D3.3.1. Integration of VR and MR as complementary Tools in the Curriculum

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The ALLVIEW project is a new transnational cooperation platform that connects Centres of Vocational Excellence (CoVEs) within the wood and furniture sector. ALLVIEW has operational objectives on a regional, national, and European level which aim at an innovative approach to modernising vocational education and training.

1

Overview

1. Overview

This document reports the results performed in tasks **"T3.2 - Development of AR, VR, MR base environments" and "T3.3 - MR, VR and AR toolkit" in the framework of the WP3 "KET kit for training in the F&W sector".**

During this work package, the consortium has explored new forms of training using key enabling technologies as teaching tools. The final goal was to investigate new teaching methods based on the project approach and in which students and teachers use Industry 4.0 technologies as enablers in the classroom.

The technologies covered in this work package were 3D printing, Mixed Reality (MR), Augmented Reality (AR), Virtual Reality (VR) and 360 videos. In this report we focus on immersive technologies, as deliverables "D3.4: Definition of new exercises using 3D Printing" and "D3.5: New exercises using 3D printing (including 3D models)" cover all the work developed on 3D printing.

The work carried out in this report is based on the findings of deliverable "*D3.1: Selection of technologies related to AR, VR and MR*", available on the project website. In this report it was established that the most appropriate technologies to develop in this work package are MR (which encompasses the characteristics of AR) and VR. In the case of VR, immersive and non-immersive experiences and 360° videos have been considered.
In this context, 10 exercises have been developed focusing on the furniture and wood sector in four different environments.

The structure of this report is divided into several parts. The first part introduces the work done for the development and implementation of the environments and exercises. The second part presents the study technologies, their use in education and, more specifically, in the furniture and wood sector. Then, the main learning outcomes obtained by these technologies in the classroom, and their connection to future job demands in the sector are introduced. In the fourth section, the integration of these technologies into classroom activities in VET courses is discussed in a generic way. Following this, the 10 exercises that were developed using these immersive technologies are presented, and the document concludes with the main conclusions.

Allview

2

Development and implementation of virtual environments and exercises

2. Development and implementation of virtual environments and exercises

One of the objectives of Work Package 3 was to develop a set of exercises that serve as examples of the possibilities offered by immersive technologies (AR, VR, and MR) in supporting training in the furniture and wood sector. The aim was to create three-dimensional experiences that motivate students, help them learn about the technologies, and gain a better understanding of the topics and concepts through their use.

To create these exercises, we worked with four different environments, which are explained below:

1. Virtual Reality environment developed for Allview.
2. Immersive 360 Videos.
3. SimLab Platform
4. Microsoft Dynamics 365 Guide.

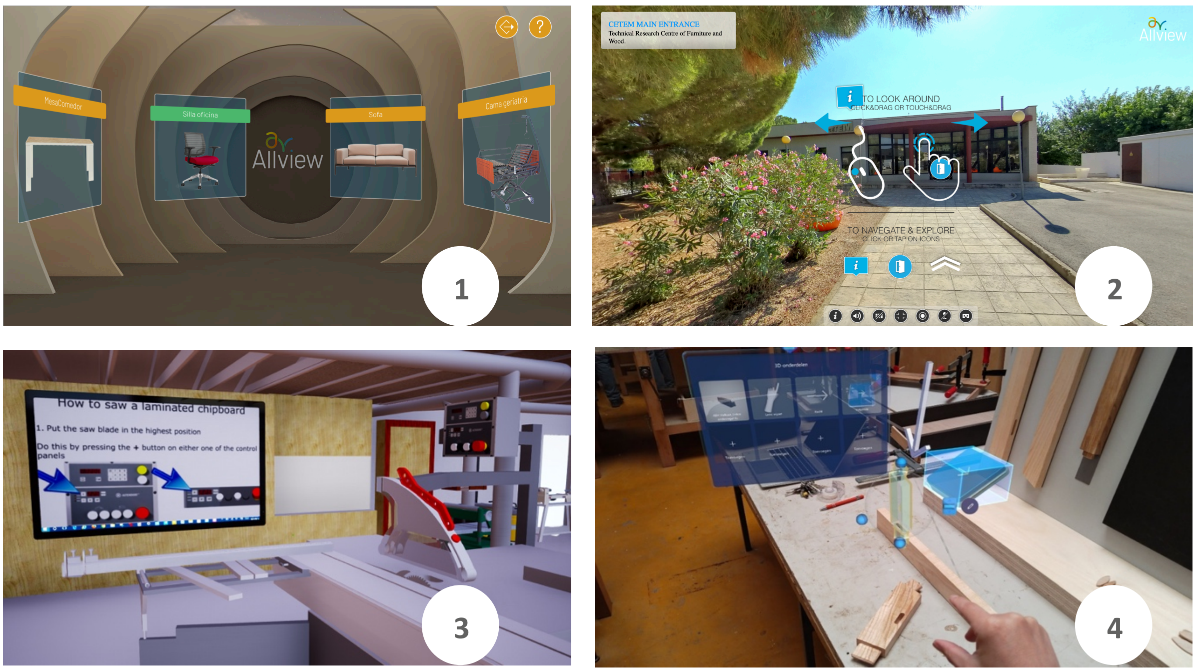


Figure 1: Environments Interface.

ENVIRONMENT 1: Virtual Reality environment developed for Allview (Four Exercises).

EXERCISE 1: Furniture for domestic use – dining table. Description.

EXERCISE 2: Office furniture - chair. Description.

EXERCISE 3: Furniture for domestic use - sofa. Description.

EXERCISE 4: Hospital furniture – geriatric bed. Description.

ENVIRONMENT 2: Immersive 360 Videos (Two exercises).

EXERCISE 5: CETEM FabLab tour.

EXERCISE 6: CETEM Furniture testing lab tour.

ENVIRONMENT 3: SimLab Platform (Two exercises).

EXERCISE 7: Operate table circular sawing machine for sawing a laminated chipboard in VR.

EXERCISE8: Operate table circular sawing machine for sawing massive wood in VR.

ENVIRONMENT 4: Microsoft Dynamics 365 Guide (Two exercises and one manual).

EXERCISE 9: Assembling a hall cabinet with Mixed Reality.

EXERCISE 10: Instructions with the HoloLens for working with CNC machines.

MANUAL: Mixed Reality manual – Microsoft Dynamics 365 Guides (Annex 6).

Development of a Virtual Reality Experience for training

The environment has been developed and implemented from scratch specifically for Allview. This immersive experience consists of 4 exercises through which the student will acquire knowledge about dimensions, design tips, techniques, and materials for ergonomic furniture design.

Interaction design and prototyping

To begin the structuring and design work, several meetings were held between the agents involved in the project in which the objectives to be met by the application were established, the needs of the users were determined and the specifications for the development were defined. The development, design and pedagogical teams were involved in this phase.

Based on this information, the development team draws up a system diagram specifying the organisation, structure, navigation, and operation of the application.

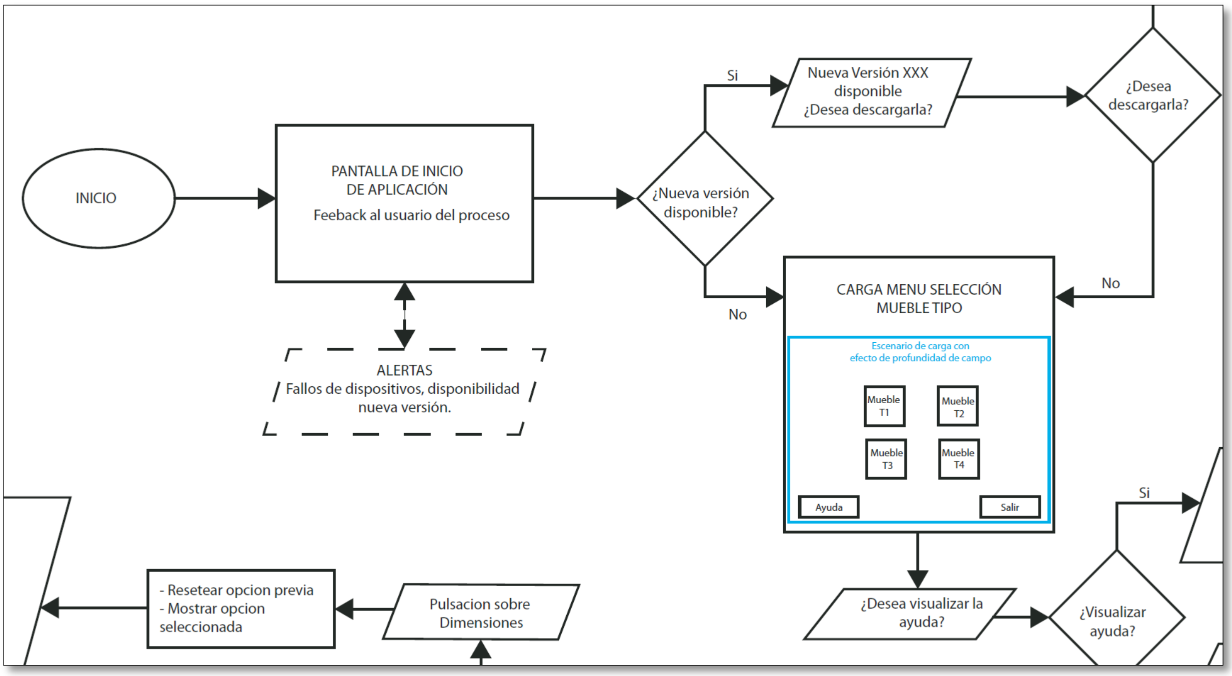


Figure 2: Technical specification diagram of the VR application.

This work is reflected in a low-fidelity prototype in a clear and comprehensible form, which is used as a reference for the next stages of technical development.

See Annex I: Low Fidelity Prototype – Allview Environment.

Behavioural and user interface design

At this point the design team established the appearance of the user interface and its elements, as well as the behaviours and interaction with this interface, defining all its graphic aspect, the behaviours of the different elements and the usability of the different interactive areas of the application.

The generation of graphic content generated in this phase was done with Adobe software, mainly Illustrator and Photoshop.

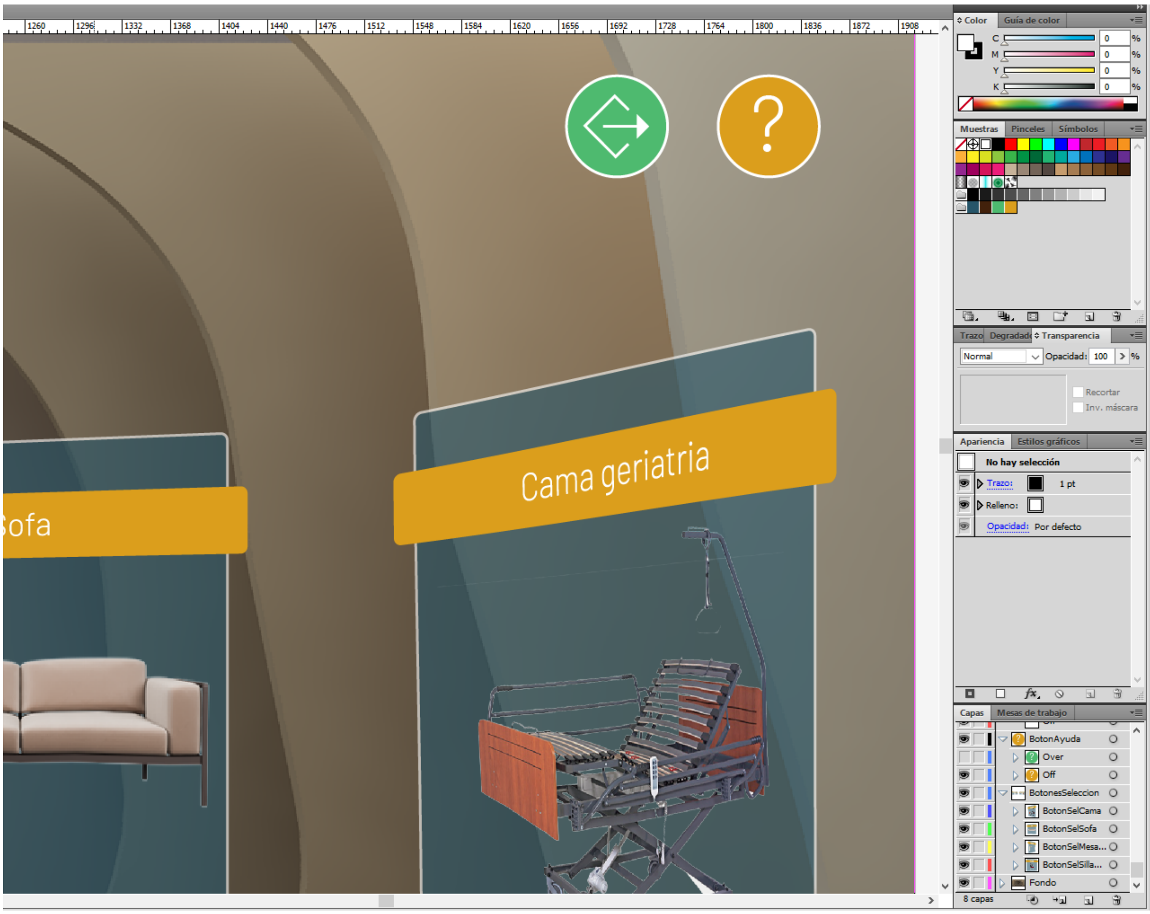


Figure 3: User interface design.

The result of this phase was summarised in a high-fidelity prototype that reflects the design and interaction with the different elements of the user interface.

See Annex II: High Fidelity Prototype – Allview Environment.

Application development

This stage begins with the analysis of the application, making all the structure and hierarchy of classes, objects, methods, and main variables, thus structuring the code that was developed. This document was an essential guide for the programming team when creating all the application code.

This work is reflected in the class and object diagrams for each of the scenes that make up the application.

See Annex III: Class Diagram Allview VR.

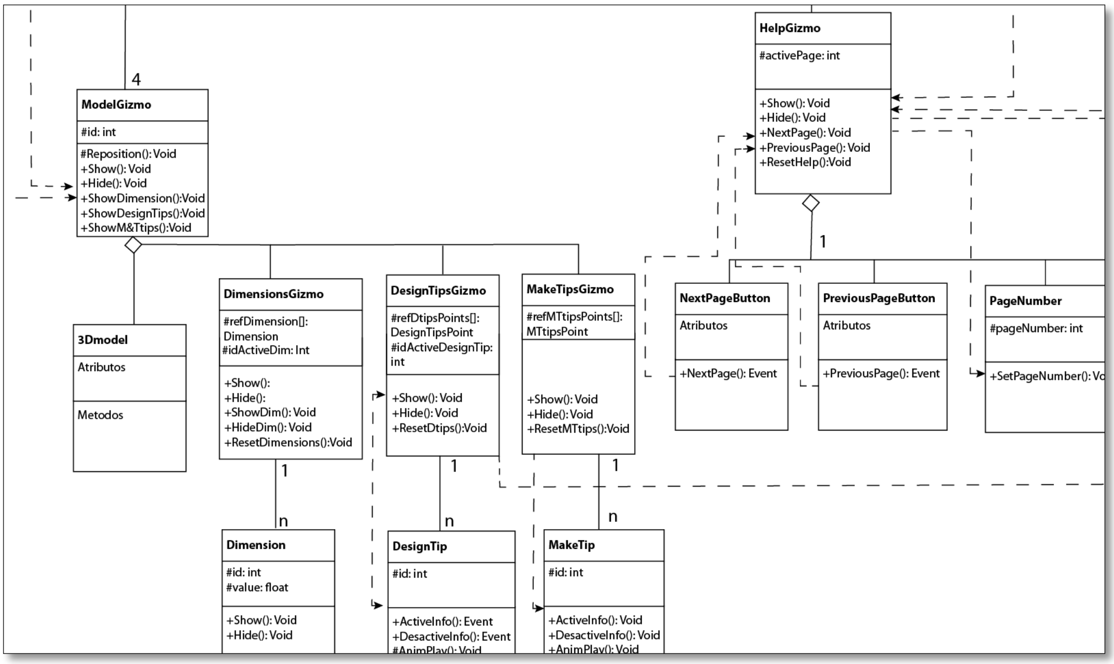


Figure 4: Section of the class diagram.

With the analysis work done, the entire application was coded, mainly in C# language, in the Unity application development environment.

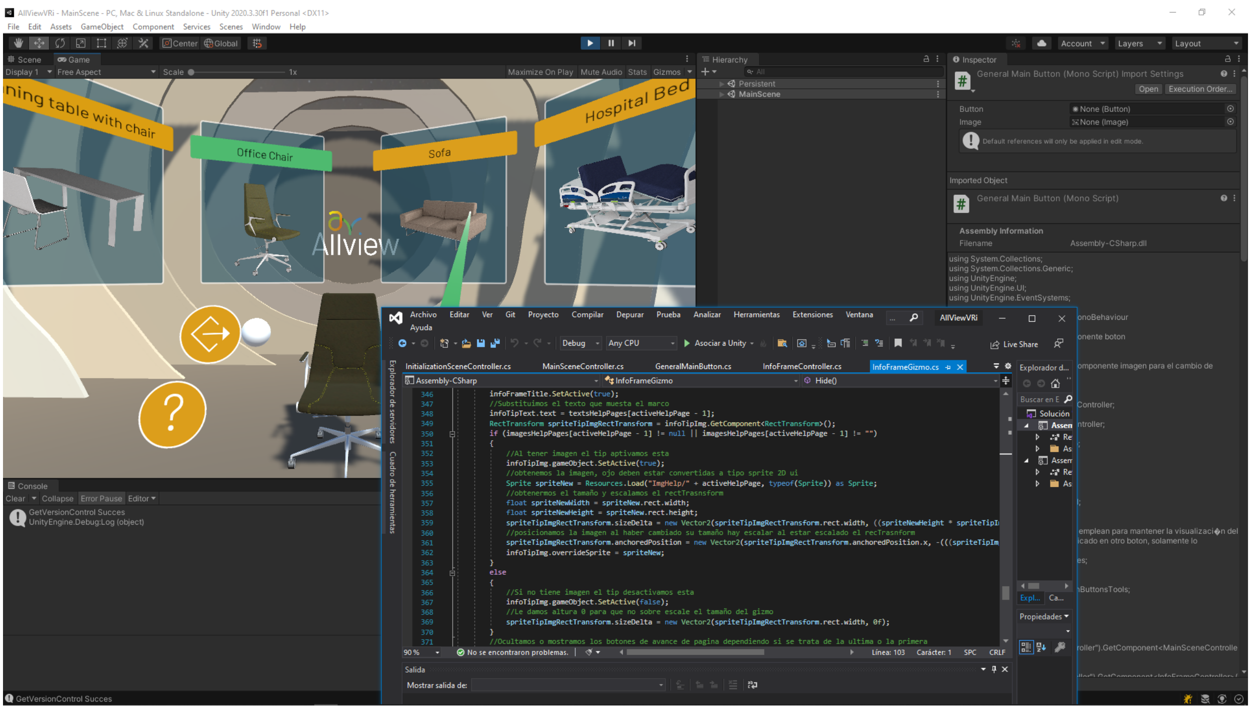


Figure 5: App development.

Incorporation of content

In parallel to the previous phase, all the necessary content for the application was developed, creating the different 3D elements and the necessary material for the simulation of its materials, such as textures, auxiliary procedural maps, text elements, images, etc., which were progressively included in the development, generating each of the 4 exercises that make up the immersive experience.

The modelling work was carried out using 3D Studio Max modelling software, and Photoshop editing software was used to edit textures and images.

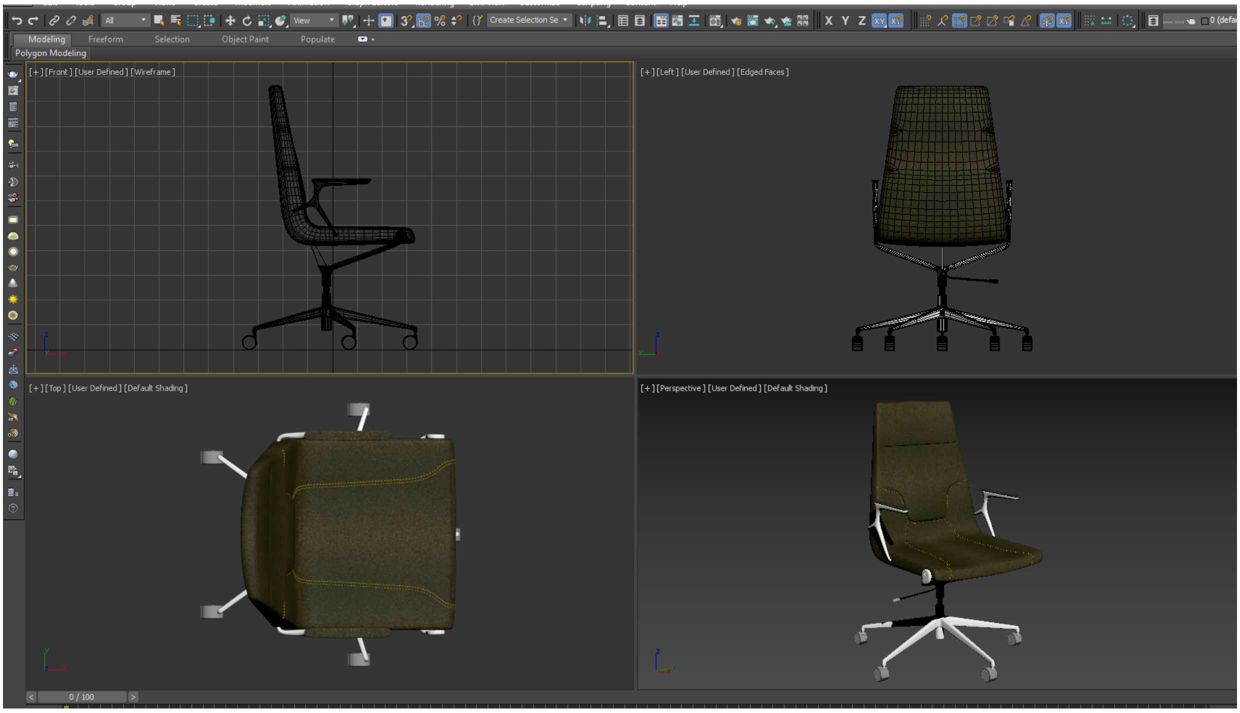


Figure 6: Modelling of the different elements.

Verification and publication tests

Finally, the application was exposed to functional testing for debugging and performance testing to maximise the application's reach on Windows systems. These tests have included monitoring of key resources, as well as empirical testing by disparate user groups to detect bugs and assess the user experience.

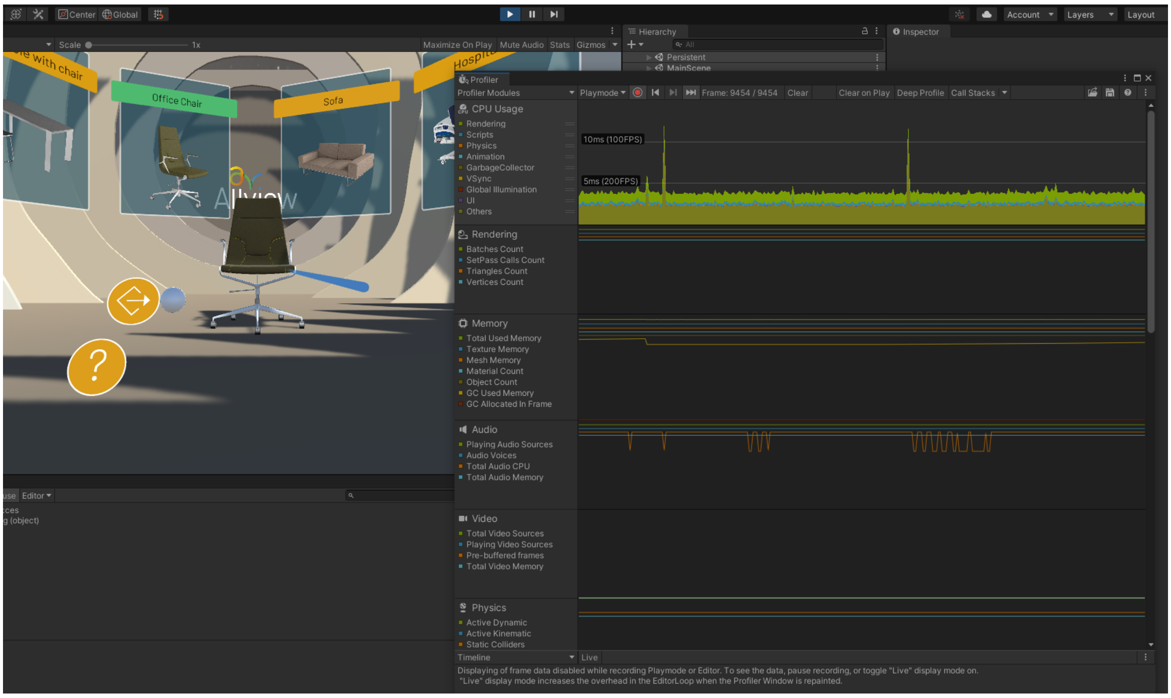


Figure 7: Verification and publication actions.

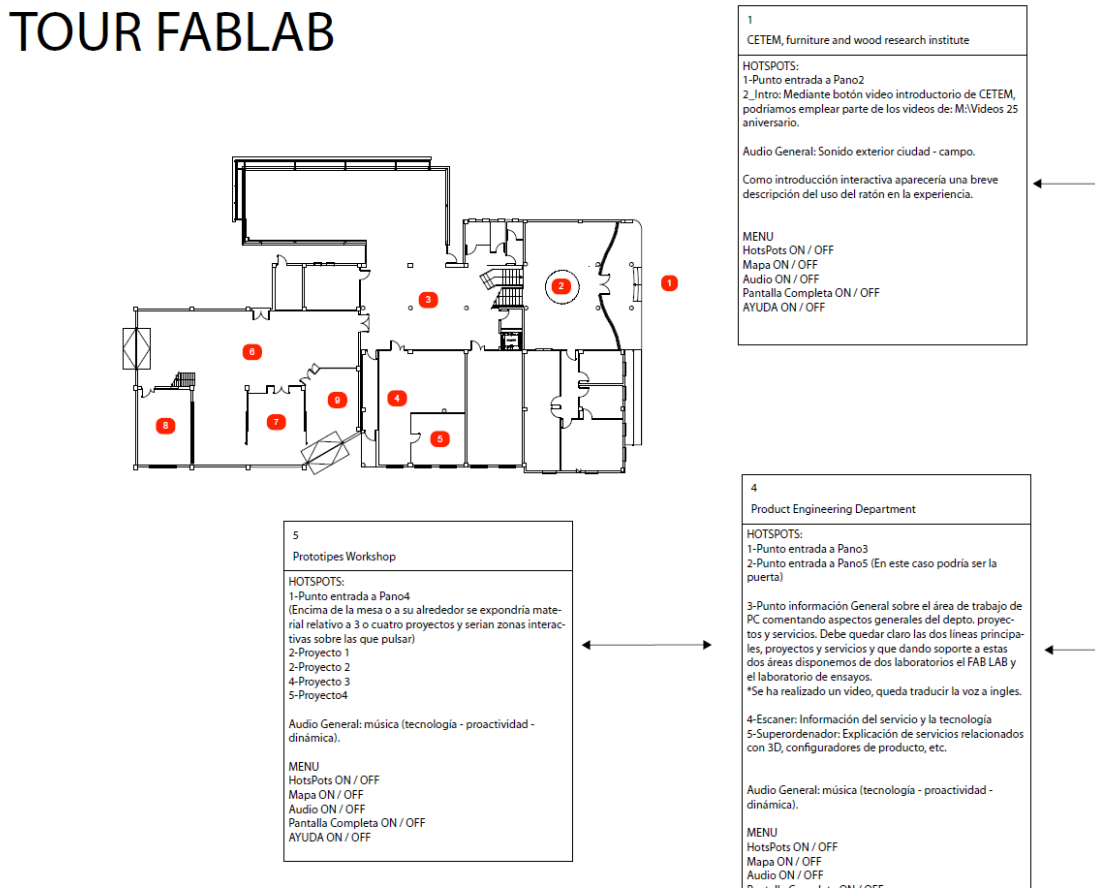
As a result of this phase, the executable for Windows systems of the developed application is obtained.

Development of 360º videos for training. Immersive experience

This experience consists of 2 exercises through which the student will acquire knowledge about design techniques, design methodologies, prototyping, rapid manufacturing, and validation techniques for finished products.

Interaction design and prototyping

Through working sessions between the different agents participating in the project, the objectives of the experiences were established. Based on these objectives and the needs of the users, the different specifications of the application were defined. Collaboration between the development, design and pedagogical teams was present throughout the development process. This work was reflected in two diagrams, one for each exercise or experience, which set out the guidelines in terms of content, structure, and navigation.



These two diagrams constitute the low-fidelity prototype experiences.

See Annex IV – Low Fidelity Prototype. 360 Video Tours.

Behavioural and user interface design

Everything related to the Frontend layer of the application was defined here, specifying the appearance of the user interface, its elements and functions, typographies, etc., as well as the interactivity of each element and its usability.

Illustrator and Photoshop software were used to generate the content for this phase.

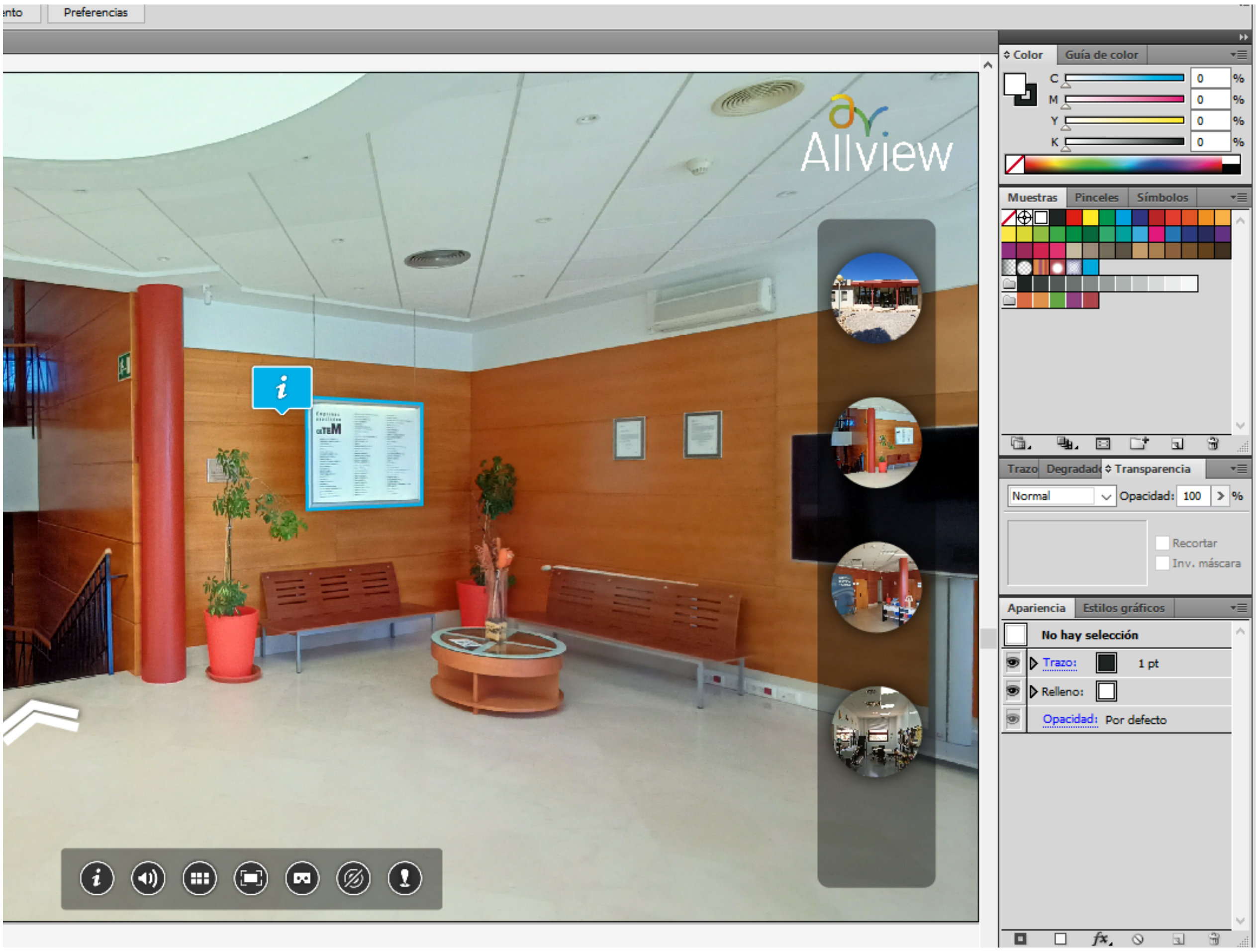


Figure 8: Behavioural and user interface design.

This work was summarised in a high-fidelity prototype that reflects the design and interaction with the different elements of the user interface.

See Annex V- High Fidelity Prototype. 360 Videos.

360° image capture

During this phase, a set of spherical images of the experiences were captured using an INSTA 360 Pro 2 camera that incorporates 6 fisheye lenses. Once the different shots were captured, they were selected and processed, joining the different images, and generating stereoscopic versions to be able to reproduce the volume effect in immersive devices such as Vive, Oculus, etc. This processing was carried out using Insta's proprietary software, Insta360 Stitcher.

Figure 9: 360° image capture. INSTA 360 Pro2 camera.

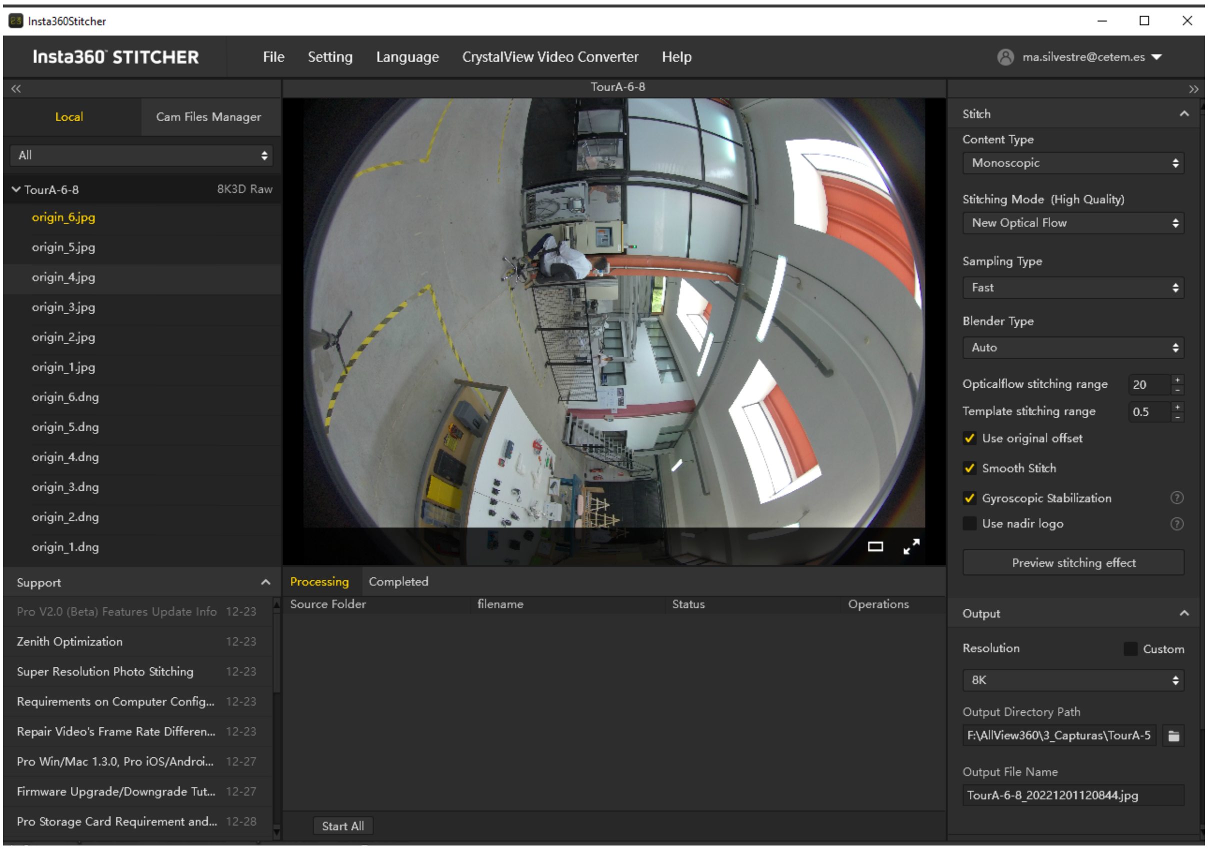


Figure 10: Camera software - Insta360 Stitcher.

Development of the content

In this task, all the content of the experiences, including images, texts, videos, audio, graphics, etc., was prepared. This was developed by the design team using the Adobe Creative Suite package for its usage more specifically, the editing of the different videos was carried out with Premier and Audition, the different graphic elements and texts were generated using Illustrator, and Photoshop was used again for image editing.

The preparation of the videos was one of the most complex tasks in this phase, as they combine graphic elements, videos, texts, and audio. For the audio, we had a recording booth that allowed us to obtain the required quality for the recording of the videos.

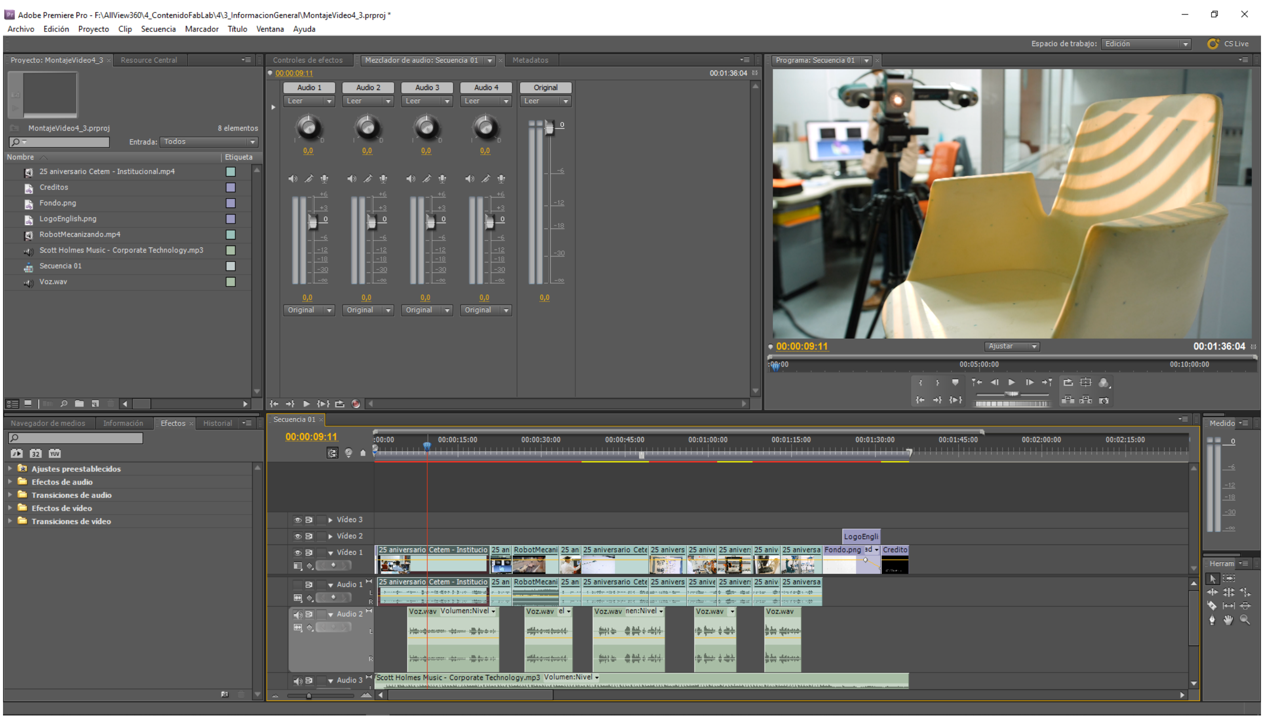


Figure 11: Recording and editing contents.

Figure 12: Voice recording.

Creation of the tour

In this task, the interactive tour experiences were created, providing interactivity and content to the different 360 images captured of the real environments. This task was carried out using the specialized 3DVista Virtual Tour software. In it, the different navigation actions are programmed, interactive areas and elements are generated, spherical environmental audios are added, and the user interface is also programmed and configured.

Figure 13: Creation of the tour.

Publication

After completing the work of creating the tour, the experience is published, opting for the web as the media for this, as it allows wide distribution and compatibility in both operating systems and immersive virtual reality devices, if such a device is available to enjoy the experience.

Virtual Reality Exercises with SimLab platform

In VR, the student will stand in front of an Altendorf table circular sawing machine, the most widely used circular sawing machine in Europe, and will have to perform all the necessary steps to saw a laminated chipboard into smaller pieces. Two exercises have been developed in this environment.

SimLab has been used to create training exercises in Virtual Reality related to the handling of complex carpentry machinery, specifically for the Altendorf table circular sawing machine. This software provides certain tools to produce this type of experience in a relatively simple way. SimLab can also be understood as a kind of CMS content manager, but instead of being dedicated to web development, it is focused on the creation of VR experiences and content.

Therefore, SimLab was considered an interesting platform for training centers to create their own content for Virtual Reality experiences without the need for specific development.

To use the Altendorf table circular sawing machine in the VR training exercises a 3D model of the table saw was needed.

A usable 3D model was not available so one was created by means of reversed engineering.

This was done in AutoCAD but could have been done in any other 3D modelling software.

Also, a 3D environment was needed to situate the 3D model of the table saw, which was found on the 3dwarehouse.sketchup.com website, a website where rights free 3D models can be downloaded.'

A 3D model of a workshop with other carpentry machinery was found.

Both the 3D models were imported in the SimLab software.

SimLab software can create animations of 3D objects in the scene, for example, a saw blade can be made spinning around.

SimLab software uses node-based visual programming to create the interactions in VR. This is done by the so-called Training Builder. A screen on which nodes are place and attached to each other. Nodes can be inputs, events, or responses.

So, for instance when a knob on the 3D model of the table circular sawing machine is touched by the controller in VR, the saw blade should start spinning and the sound of a saw blade spinning should be heard.

In this case the training builder looks like this:

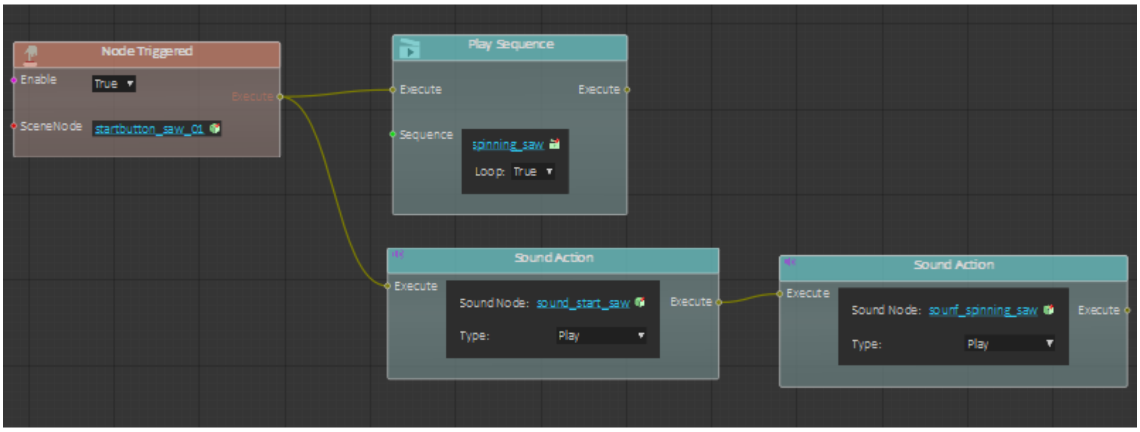


Figure 14: Training builder.

This way the whole exercise was created, and a typical Training Builder sheet can look like this:

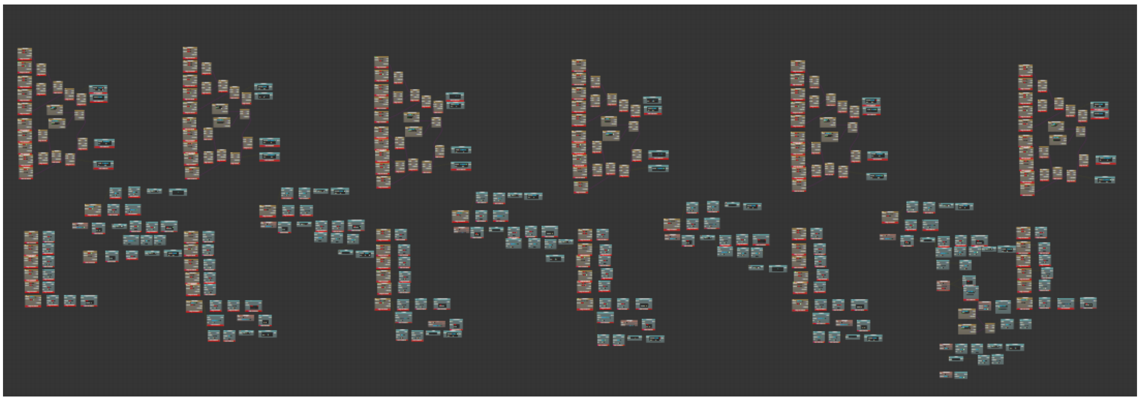


Figure 15: Training builder sheet.

Every time something was added or changed in the exercise it was tested by sending it to the VR device.

This was done either connecting a VR device with a cable to the computer and start the exercise or by sending the exercise to a SimLab Cloud and opening that cloud on a standalone VR device and start the exercise.

Mixed Reality Exercises with Microsoft Dynamics 360 Guide

Two exercises have been developed in this environment. Through an additional virtual layer with HoloLens, students and teachers are instructed to perform certain actions on a CNC machine and in the assembly process of a cabinet.

Choosing the platform

Initially, the intention was to design a platform and build it. But the costs for the realization of this platform were too high and further development would cost too much. That is why it was decided to use Dynamics 365 Guides platform from Microsoft. It is very user-friendly, and the consortium had experience using Microsoft products.

The license fee for this platform is also affordable for education. Other platforms were not affordable for education.

Reasons:

Accelerate learning, standardize processes, and reduce errors to increase yield with step-by-step instructions to help keep them safe on the job.

Microsoft Dynamics 365 Guides is a mixed-reality application for Microsoft HoloLens that helps operators learn during the flow of work by providing holographic instructions when and where they're needed. These instruction cards are visually linked to the place where the work is done, and can include images, videos, and 3D holographic models. Operators see exactly what needs to be done, and where, so they can get the job done faster, with fewer errors and greater skill retention.

Platform description and use

With Dynamics 365 guides, no specialised 3D or programming skills are required. Start with the PC authoring app to create a guide consisting of step-by-step instructions, images, videos, and 3D holograms. After creating the guide on a PC, use the HoloLens app to connect the instruction cards and holograms to the physical workspace by picking them up and moving them to the correct location. It is possible to use the default library of 3D holograms to get started and it is also possible to import your own custom 3D models.

Built-in authoring on PC

Easily create content with ready-to-use holograms from the 3D toolkit to demonstrate task steps in the physical space.

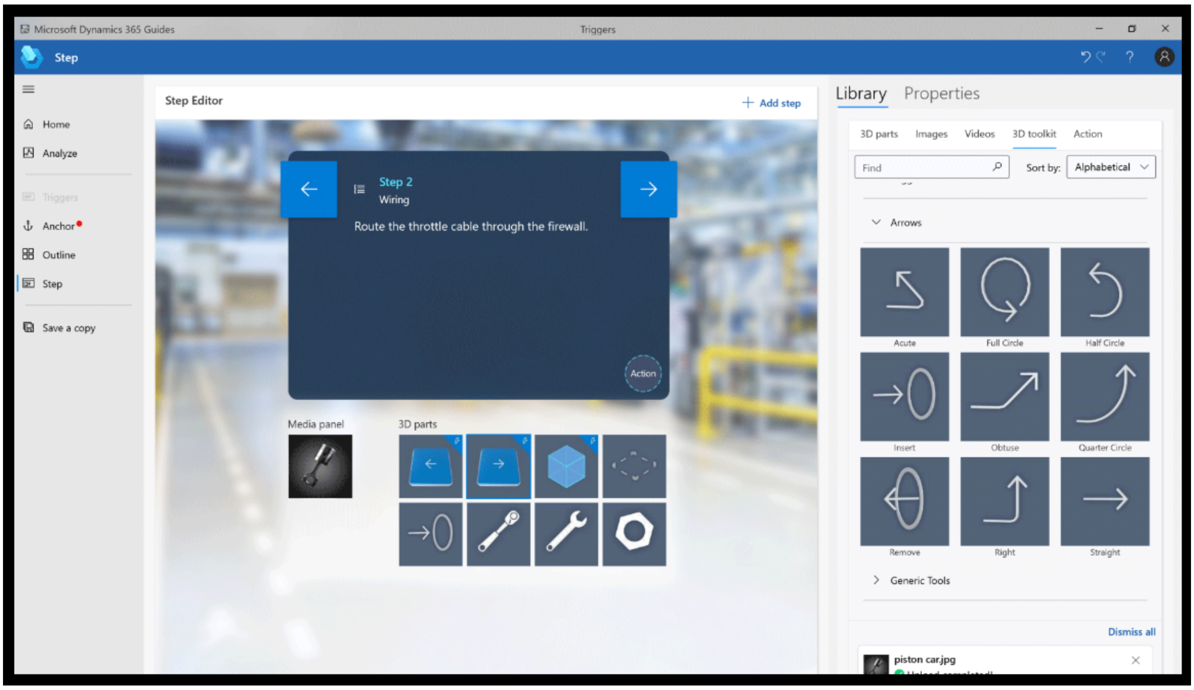


Figure 16: Authoring on pc.

HoloLens app. Author mode

When your Guide is created in the authoring app on the PC, you can open your Guides app on the HoloLens.

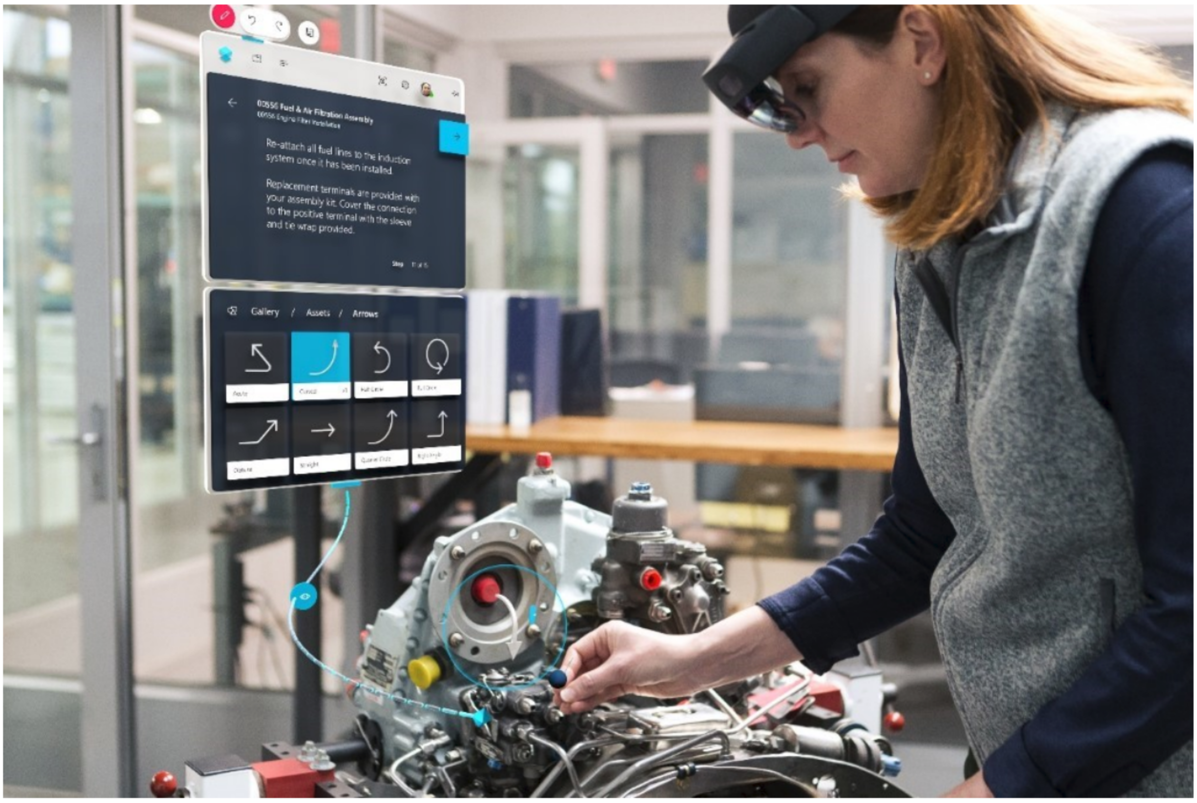


Figure 17: Author mode HoloLens.

Operate

When you open a guide as an operator by using the Dynamics 365 Guides HoloLens app, you see the Step card. The Step card is the hub of everything that you do in a guide. It provides the instructions that you follow to complete the task. It also includes two buttons that you use to navigate through a guide: Next and Back. As you go through the steps in the task, the Step card follows you on HoloLens, to keep the instructions where you need them.

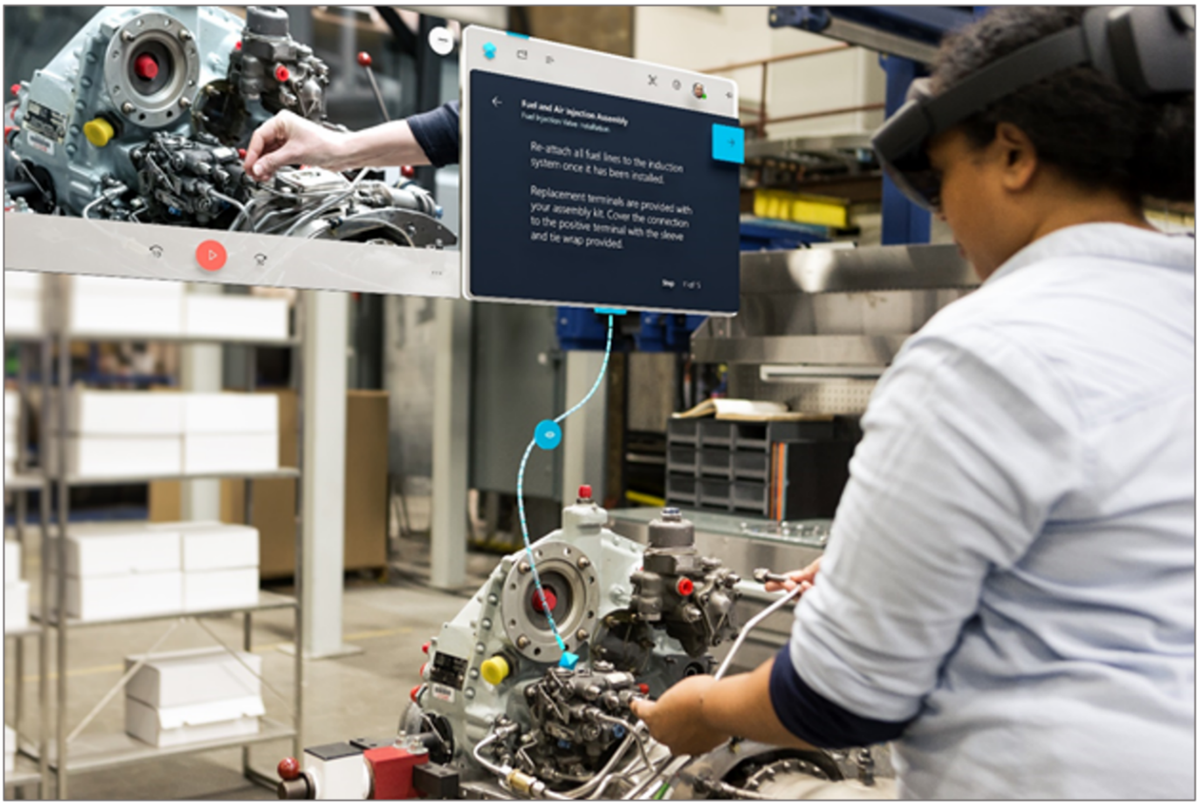


Figure 18: Operate guide HoloLens.

Exercises

For the exercises, we started from the needs of the teachers. Where is there a need for extra support from the teacher.

For the Hall Cabin, it was necessary to simplify the entire process from planning to realization. The students were already given explanations about everything, but students who connect later or have difficulty with the speed can repeat or learn the subject matter at their own pace.

By mounting the hall cabin, they get to know the different connections and also, they get a better technical insight into the exercise. Students must draw the exercise out themselves in AutoCAD, but also have to realize the exercise.

For the second exercise, manual use CNC 3-axis machine, we gained all the knowledge at the mechanics department. There we already used dynamics 365 guides for a manual for the CNC machines. This manual always starts with the safety instructions of the machines. After that, you can choose which procedure you want to follow. Load new program, change tools, start machine.

3

Use of Immersive Technologies in Education

3. Use of Immersive Technologies in Education

Computers, Internet access, collaborative learning platforms, specific software for teaching and learning, etc., are the most common Information and Communication Technologies (ICT) used by teachers and learners to complement and expand the contents of textbooks and workbooks. Their use is mainly focused on making the information and training contents more accessible and interactive and, since 2020 their use has been extended to all educational levels around Europe – mainly Secondary schools, VET (Vocational Education Training) and HE (Higher Education) - pushed up by the Covid-19 pandemic, that forced educational institutions to use them to teach remotely [1].

For several years, the immersive technologies, that are , those classified as extended reality (XR) technologies – term that includes augmented reality (AR), virtual reality (VR), mixed reality (MR) technologies and 360º video - are being investigated and tested to be used as those promising technologies aimed at enhancing the teaching-learning methodologies in educational systems, to improve the quality of education through the creation of immersive and more stimulating learning scenarios in which students increase the human perception of the training contents [2] [3]. With immersive technologies people can learn through the virtual experience that these technologies can offer for many different disciplines. They can also break down the barriers that some students could experience due to disabilities, and are the key to offer more attractive courses, engaging students in the increasingly competitive world of VET/HE providers [4] [5].

Immersive technologies, also known as XR (Extended Reality), have already been proved as success technologies in medical, military and aviation disciplines [6], in which their use for simulation and practice-based training are highly effective and is being extended year by year. In education many researchers are already beginning to demonstrate the benefits of such applications, including increased understanding, memory retention and task performance [7]. Educational institutions and educators who can combine the benefits of building virtual worlds with the enhanced experience of AR will transform teaching experiences for the next generation of learners.

Figure 19: Nasa Virtual Reality Lab [6].

However, in VET/HE, the use of XR is being slower than expected, although Universities and Colleges have always been at the forefront of introducing innovative technologies, driving the progress, and training the next generation of scientists, developers, and entrepreneurs. It is true that to modernize the teaching environments with XR is not an easy task due limiting reasons, e.g., lack of knowledge regarding the XR technology and its powerful in education, lack of teachers trained for their use, big investment, and other bureaucratic and administrative barriers, among others, [8] [9].

With the aim of promoting and extending the use of XR technologies in education, the following sections present (1) an introduction to XR technologies, (2) a set of use cases and real-life examples of their use in education, and finally (3) a list of the main benefits that students and educators can obtain of using XR.

What are immersive technologies (MR/VR/360Videos)

Immersive technologies are mainly VR, AR, MR and 360◦ video. They are commonly called extended reality (XR) technologies. Although XR technologies have been already described in *D3.1 "Selection of technologies related with AR, VR and MR"*, it is necessary to do a brief description of them focused on their use in education and emphasizing their main differences.

Virtual reality (VR) is the technology used to provide a full virtual experience that completely immerse the user in a virtual environment created by an application or program executed in a local or cloud computer/server. It offers visual and sound content. Sound complements the virtuality and creates the effect of presence in an unreal location by simulating the reflection and directions of sound waves. The perception of the virtual model/object/scenario with a high degree of reliability allows to train students qualitatively and quickly in various specialties: aviation, process control, medicine, remote control of technical means and more. All these features of VR make it an ideal educational tool that allows to visually conduct lectures, seminars, workshops, demonstrating to learners all aspects of a real process, objects, environment, etc., which in general gives a huge effect, improves the quality and speed of educational processes, and reduces their cost.

Figure 20: Example of immersive learning experience with VR by Trek view [10].

Over the last decade, VR has become a leading technological trend in the development of educational technologies. This is due to the powerful investments of technology companies that help to improve VR systems, while increasing consumer access and interest in these technologies. Some examples of VR devices on the market that are suitable for education are:

- VR glasses: They divide the picture in front of the eyes into two parts, creating a stereoscopic effect. In the presence of tracking for body positions, the virtual space also considers the movements of the head and torso.
- Smartphones that support VR applications: they are inserted into the case with lenses – Google Card-board.
- VR gloves: devices used instead of the usual joystick, so that human hands naturally interact with the virtual world.
- Mobile VR helmets: they are devices with built-in monitors (HTCVive, Oculus Go and others), optimized devices with high-quality graphics, integrated sound, and joystick for control.
- Standalone VR helmets: (like Oculus Rift), graphics to which are transmitted via wires from a gaming computer with a powerful video card, communication with a PC creates restrictions on use, but VR helmets have better graphics and more potential purposes for users.
- Tracking systems: allow moving the user into the virtual space, and the costumes that convey feelings from virtual reality are also being worked out.
- Trekking cameras: capture the position of the joystick and the position of the person, immersing him other in VR more realistically, complete with helmets are controllers.

Augmented reality (AR) mixes the real environment with the virtual one, creating a mixed reality, 75% reality and 25% virtual, also called hybrid reality. AR projects any digital information (image, video, text, graphic, etc.) on top of the screen of the device, imposing the digital (virtual) elements on real objects and backgrounds. Where VR creates new, remote and, imagined worlds, AR technology augments the physical world; adding layers of data onto what we can see with the naked eye. It augments and contextualises our vision with information, sound, video, and graphics.

Using AR in the classroom can improve learning by helping educators create interactive classrooms that increase student engagement. Teachers can show virtual examples of concepts and add gaming elements to provide a more attractive training material.

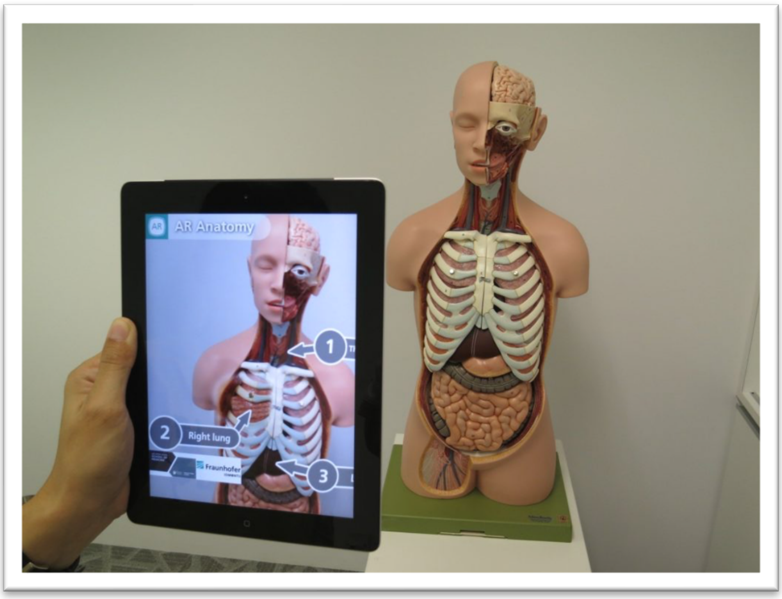


Figure 21: Example of Augmented Reality app used in education [11].

AR can be implemented using applications for ordinary smartphones and tablets, AR glasses, stationary screens, projection devices and other technologies. Most of smartphones and tablets in the market have AR capabilities. One example of its extensive use worldwide is the videogame (AR app) Pokémon GO, very popular in 2016 with more than 232 million users.

Mixed Reality (MR) combines elements of VR and AR. Like AR, it overlays digital content with the real world. This content is anchored to and interacts with objects in the real world. The major difference between MR and AR is that in mixed reality, digital assets can be visibly obscured by real world objects. MR requires a variety of digital mediums to accomplish the mixed reality environment. This includes:

- Head-mounted displays like the Microsoft HoloLens headset.
- Head-up displays, which project images into a user's field of view without obscuring the environment in front of them.
- Automatic virtual environment called CAVE in which a user is surrounded by projected displays.
- Mobile devices and apps to create mixed reality by overlaying computer graphics across the user's physical view.

Some big companies like Microsoft are pushing up the use of MR in education through many free apps and specific software/hardware [12].

Figure 22: *Example of Mixed reality used in classroom* [12].

Panoramic and 360º photos and videos are sequential sets of pictures sewn by means of algorithms, it is possible to make them both by one camera, and special 360° cameras. Cameras which take pictures of surrounding space then the received videos are sewn up in special programs. There are also seamless solutions, but they are more expensive, some-times additional graphics are added to the finished video. Nowadays, "panoramic" online broadcasts are also common, when you have several points with a panoramic view, which give the viewer the opportunity to "be present in the moment". A lot of 360º videos can be found on the Internet for education purposes, like in VRSYNC [13] with 15 high quality VR-360º videos resources for education.

VR, using a 360-degree image, carries a person into the artificial world, where the environment is completely changed. We can get acquainted with AR only with the help of a smartphone, but to dive into the virtual space you need to have a special helmet or goggles.

How to use these technologies in education

XR technologies are gaining popularity in VET/HE institutions. They seem to be a natural next step in the education progress. Nowadays, there are a lot of public and private initiatives, real examples, use cases, etc., focused on creating attractive student experiences and delivering innovative technology-enabled teaching. There are also some teachers' guidance's published for the classroom use of XR technologies, promoted by international teachers' organizations [14].

In this document we summarize the most popular use cases of XR to inspire educators.

1. **Training lessons through virtual field trips**. Virtual field trips are a widespread application of VR technology in the education and industry. It enables students to explore different

locations, most of them real locations on earth, “teleporting” them to places that may be infeasible to visit in real life due to different reasons and providing them a "near-life" experience that may not be possible in a traditional classroom setup. Popular applications in this field are provided by *Google* [15], [16], that can be used in arts, history or science lectures. It allows students to do a virtual tour to museums and other historical and natural sites.

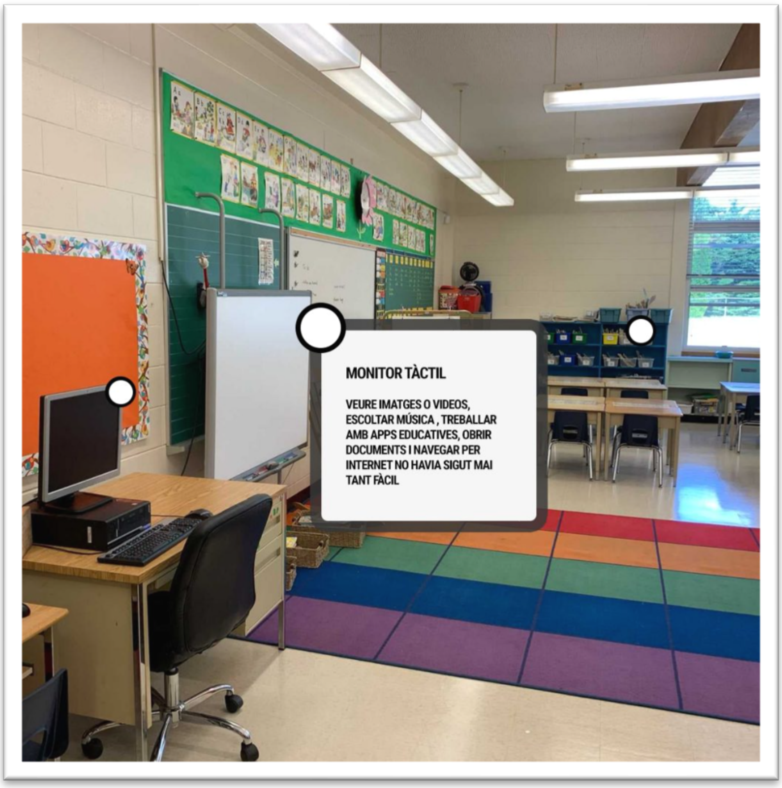


Figure 23: *Virtual tour in a classroom with 360º video* [17].

2. **Training lessons with virtual objects and concepts with AR**. Educators can use AR to enable students to see 3D objects in the classroom, creating a more attractive and easier to understand training material. One popular AR application for education is *Google* Expeditions [18], which enables to see a lot of 3D objects in the classroom: volcanoes, storms, DNA chain, etc. This application provides more than 100 AR expeditions, including history of technology, the moon landing, among others. There are many others sophisticated AR applications for different VET/HE disciplines, e.g., in [19] a teacher-created AR application is proposed for high school students to explore vector geometry. The project demonstrates students’ ease of use, support for classroom access and even potential for home schooling.

3. **Remote learning**. Since a vast majority of students in VET/HE have Internet connection, VR can be used as a driver for facilitating students to learn from the comfort of their homes but offering an immersive and authentic classroom experience. It is true that nowadays VR devices may seem a bit expensive, but there is no doubt that VR has potential to replace conventional learning methods soon [20].

4**. Practical Training lessons in safety scenarios and virtual labs.** VR simulations and some AR/MR applications offer a powerful tool to practice and support students to enhance their practical skills in safety scenarios and/or virtual labs. One of the advantages of using VR/AR/MR for training is that they present a safe environment, where students can polish an unfamiliar skill without worrying about inflicting damage to a person or a property. The risk-free environment encourages students to explore new techniques and learn from their mistakes, being more confident with the training. Moreover, virtual labs create opportunities to access advanced equipment that might not be usually available in schools. One example of this is the Virtual lab of Salus University, where students can perform virtual retinal examinations and test the skills, they have acquired in this field [21]. Another example can be found in Case Western Reserve University in Ohio, that used MR to teach *anatomy*, despite professors were hundreds of miles away [22]. There are other extraordinary virtual training experiences like the one performed by Western University that worked in an AR project for allowing students to swim with sharks [23]. It was considered a great virtual experience for training decision-making under pressure and for students in the field of biology that can explore sharks and their behaviour.

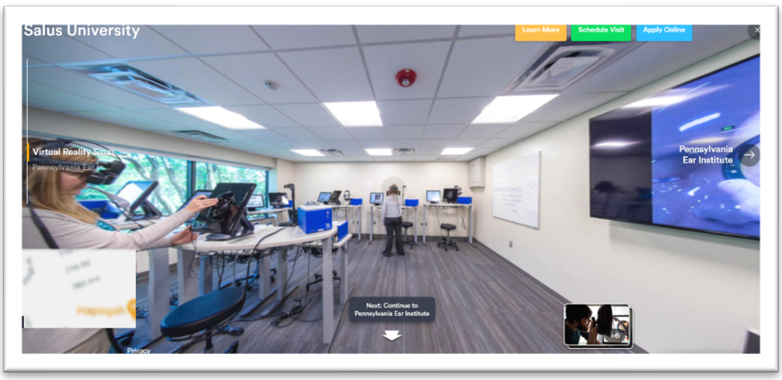


Figure 24: *Snapshot of Virtual Lab in Salus University* [21].

5.**Training of complex tasks**. XR, especially VR, are very popular in some fields where training involves scenarios not easy to perform in the real life, like e.g., medical training, where students must be trained for acquire skills in handling surgeries and other complicated operations, by eliminating the risk of harming a real-life patient. Many medical colleges and hospitals are significantly investing in VR to train.

Figure 25: *Screenshot of the trainer's view. The trainee's vitals on the left, view from inside the program in the middle, and general environmental statistics on the right* [24].

6. **Training students with special needs.** The use of textbooks or other traditional methods can be unfruitful for students with learning difficulties. Using VR in education can act as an assistive technology for students with special needs. It has been proved the greatest effect lies in *improving* communication skills, especially in students with hearing problems. For autistic students, VR seems to facilitate social interaction [25].

7. **Training in Biology, Anatomy, Dissection, and other disciplines with non-free cruelty-free methods.** Many animal rights activists and scientists are moving administrations towards the introduction of cruelty-free methods to teach in schools. VR is a powerful tool that allows educators to teach how to examine virtual animals as if real animals are. Popular tools in this field are offered by VictoryXR [26]. E.g., They developed a virtual reality frog dissection simulation that can replace the use of frog cadavers in biology classes.

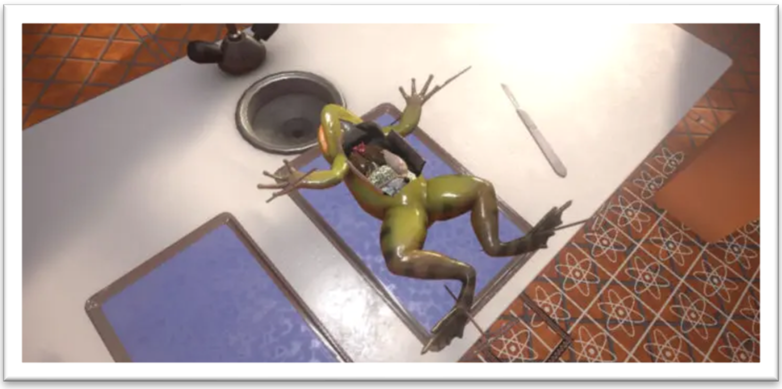


Figure 26: *VXRLabs, VXRLabs Biology by* [26].

8. **Game-Based Learning**. XR technologies can be used to offer students interactive and gamified content, increasing the student engagement, and helping them to understand complex concepts with relative ease, resulting in better grades.

9. **Learning modern and medieval languages**. Immersive technologies have been proved by the research community as effective tools for learning languages. Immersive lessons open the door to virtual scenarios and experiences where learners learn by doing [27]. There are many VR/AR/MR applications for learning languages, e.g., Mondly, that provides a virtual teacher [28].

Main benefits that the students (and educational institutions) can obtain from Immerse Technologies

Many research works have enhanced the aspects of using XR technologies in the classroom and in the teaching-learning process [29]. In this document, we enumerate the most remarkable benefits, organized by those that are mainly focused on the student (see Figure 26), and those focused on the teaching-learning process and training provider.

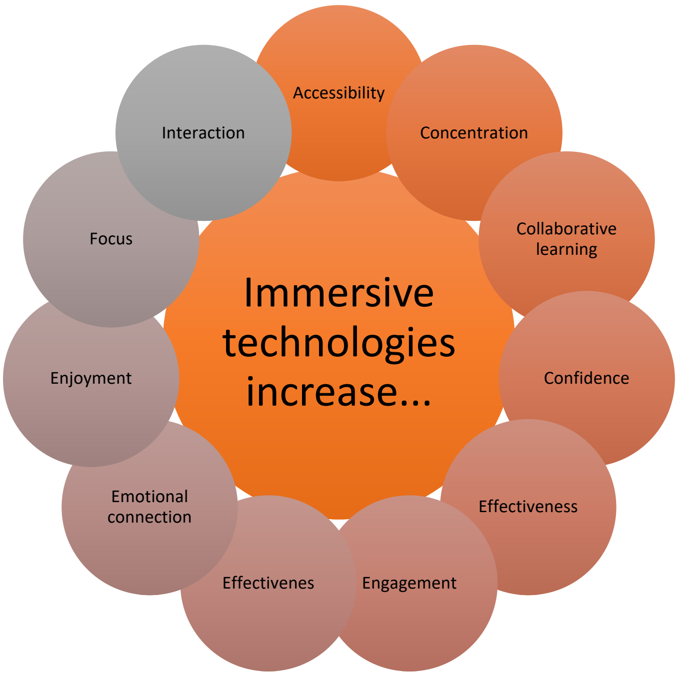


Figure 27: Benefits of Immersive technologies for students.

- **Increase concentration and effectiveness.** In a virtual environment with XR technologies, the students are fewer distracted by the external (real) environment, then students' concentration increases. Regarding effectiveness, it has been proved that those students that have used XR technologies for studying the learning material have improved their knowledge, showing better results (learning outcomes) [30].

- **Increase of student engagement, interaction, and enjoyment**. Many research works have concluded that the use of XR reduce the students' dropout rate, increasing at the same time the student's satisfaction, their enjoyment and interaction with the training material [31].
- **Increase student confidence**. Confidence is key to any form of training, but it's particularly important to soft skills. Some scientific works have measured it and concluded that learners that use XR technologies show measurable increase in their confidence. E.g. PwC's study found that learners who had used VR to be trained were 35% more confident in the skills they had learnt compared to e-learners, and 40% more confident than classroom learners [32].
- **Increase emotional connection to the training material.** Recent research works have concluded that those users that are trained with XR technologies are more emotionally connected to the training materials. This is critical when it comes to diversity, equality, and inclusion training, where learners can experience the world from different perspectives. In PwC´s study, [32] it is shown that VR learners were 3.75 times more connected to VR content than they were to material delivered in the classroom. Additionally, 75% of learners using VR also said that they empathized and felt more connected with the training material when they were learning about diversity, equality, and inclusion principles.
- **Increase students' focus.** When the students are in classroom, they can be interrupted by notifications coming from their smartphone or computer, adding distractions to the teaching-learning process. It also happens in blended and e-learning. With XR technologies, the students are involved in a virtual environment, and there are no notifications, no rolling news feeds, no distractions. XR eliminate distractions completely and immerse learners in their course content, and that's probably why some research studies conclude that the students that use XR technologies for learning are four times more focused on learning content than e-learners or classroom learners.
- **Increase collaborative learning.** XR technologies promotes social learning and encourages students to communicate verbally or through actions with teachers and other students. Especially with VR, learners can also virtually collaborate with people on

the opposite ends of the earth to discuss theories, engage with immersive content, and learn from each other.

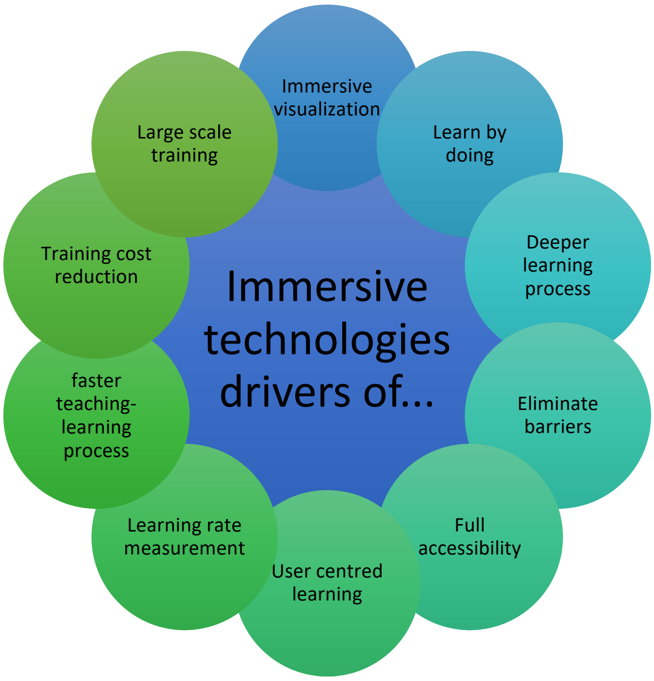


Figure 28: Benefits of Immersive technologies for teaching-learning process and training providers.

- **Immersive visualization of training content.** The training content that is being taught (e.g., a process, a concept, or an object) is experienced without any obstacle and with a high degree of detail. For example, for teaching-learning anatomy and biological concepts of the human body we can find a lot of free and commercial training apps, like Anatomyou for medical students [33], Virtuali-tee [34] or Body Planet for students at primary or secondary school [35].
- **Development of practical skills – learn by doing.** The VR allows to experience the effect of "learn by doing" thanks to the opportunity to experience with virtual practices and processes as if they were real. It contributes to a faster development of the practical skills in students.
- **Deeper learning process**. XR technologies offer a deeper process of learning thanks to the immersive environment, the interaction with the training content, and due to the increase of the student's participation in the teaching-learning process. With XR, the students are not passive listeners, but active actors of the teaching-learning, that can interact with the virtual scenario, control, and change it to conduct their own learning.

E.g., with XR students at history faculties can witness historical events, students at physics and chemistry faculties can conduct their own physics or chemistry experiments, and art students can attend a virtual art gallery tour or exhibition.

- **Eliminate barriers in the training materials**. XR is the tool for teaching those training materials or concepts that cannot be experienced in a real environment due to security risk, e.g., when training lifeguards or firemen, training students of architecture/engineering for simulation of any complex project or to conduct a complex operation, training students of chemistry to conduct an experiment with hazardous chemicals without harming oneself or environment, etc.
- **Full accessibility – anytime and anywhere.** Accessibility is an ongoing concern for educational institutions. In VET/HE the ability to teach remotely significantly reduces some of the physical barriers that some students may face when it comes to attending classes or lectures in person. Covid-19 has served to intensify this challenge. Using XR – and not just to replicate the lab environment – could allow some students to complete their studies from anywhere, whilst still receiving a high-quality teaching experience. Also thinking in blended learning, XR can be the driver to boost it. It is true that there is a key barrier for to reach the mass adoption of XR and guarantee full accessibility: the cost of VR hardware and software for students. Fortunately, there are some ongoing projects that are working to address this challenge, e.g., Edify by removing the need for students to have VR headsets, allowing them to dial into their teacher's vision and virtual classrooms via widely used video conferencing platforms. The authors call it 'VR by proxy', or 'shared immersion' [36].
- **User-centred learning - Personalisation of the learning experience.** XR has the true potential of a very fine-grained personalisation of learning. Using data analytics integrated in the background of the XR system used, educational institutions and teachers can better understand natural learner profiles, and to use that information to develop highly individuated, improved pedagogy. Then, XR technologies can help to present a more detailed picture of exactly how an individual student learns, enabling educators to create tailored experiences which are optimised for each learner. Undoubtedly, the use of data analytics could rely in an invasive mode in the teaching-learning methodology. Therefore, it will be applied with the students' consent.
- **Allows to measure the learning rate**. Learning experiences from the classroom need to be measurable to ensure the level of comprehension and proficiency on the part of the

learner. XR technologies can be used to monitor the learner's experiences in real time and report the results to their teachers and trainers, giving them the chance to get immediate feedback. Additionally, performance data can be recorded for analysis after the experience has taken place and repeated later to test retention of knowledge and skills.

- **Faster teaching-learning process.** Training that takes four hours in a classroom environment is delivered in one hour using the XR technologies and immersive learning. And this figure doesn't even consider the amount of time needed to get learners to the classroom. In business, employees typically spend 1% of their work week on training and development. Then, XR for training in business can also be a competitive benefit [37].
- **Training cost reduction at large scale.** The use of XR can reduce the costs of training tools, especially in complex training where the software or virtual training tools are cheaper than real machines and equipment (e.g., using a smartphone or tablet a person can get a virtual endoscope, tomograph, model airplane, tank etc.) [38]

Implement XR technologies in education in the wood and furniture industry

Is Extended Reality (XR) a significant opportunity for the future development of education in the wood and furniture industries? This section focuses on the main XR multidisciplinary technologies and methods that have the potential to cover a wide range of knowledge domains. It will be summarized what XR tools can be seen as a considerable opportunity for education and business in the wood and furniture industry, and under what conditions they might contribute to a more dynamic development of the sector.

Although the meaning of the term or abbreviation "XR" in the academic world remains ambiguous, for a regular user Extended Reality is a term for technologies that augment or replace our perception of reality [39]. This is frequently accomplished by superimposing or immersing computer text and graphics into real-world and virtual environments, or by combining the two. The term XR (as already mentioned earlier in this document) refers to augmented reality (AR), virtual reality (VR), mixed reality (MR) and sometimes to 360° photos and videos. While all realities share overlapping features and requirements, their purposes and underlying technologies differ [40].

As well as the job description and training may change, fundamental knowledge about innovative technologies must be taught during training. Therefore, it is critical to learn which job profiles will benefit from XR: VR, MR, AR and 360 degrees photos and videos, as well as which knowledge domains will be required.

Virtual Reality

VR is currently being used to create educational content by an increasing number of businesses. There are available apps that allow students and teachers to create their content, such as VR glasses. More and more interesting educational applications are appearing on the market for higher-priced glasses regularly. Aside from VR glasses, there are VR helmets and mobile VR helmets as well as smartphones that support VR applications [41].

The use of VR in education in the wood and furniture sector could be used in many areas but especially in training in the use of machines for woodworking and wood-based materials and the course of practical design of furniture and building structures.

The safety of the user is critical in the training on the use of cutting, milling, drilling, grinding, and other devices. Carpenters and amateur woodworkers are well-known throughout the world for the injuries that frequently occur when practising this profession/hobby, such as inadvertently cutting off the fingertips or fingers, or even most of them. The second critical aspect is maintaining the machine tool and its associated equipment, which can be expensive.

Augmented Reality

AR can be used for a variety of purposes, including the creation of educational materials such as interactive paper worksheets. With the usage of AR for the creation of interactive paper worksheets, the teacher can only prepare proper materials once per school year or update already existing materials and upload them into a platform, preferably in a shared account. Once a student follows the account, he or she gains an access to all the necessary content.

Another example of using AR in W&F education is following the leading role of this technology in the furniture retail transformation and adapting it into training. There are three possible process levels where AR can be used:

1) Trying before buying:
AR augments physical objects with digital content, allowing users to see how e.g., a new armchair would look in their apartment in actual time. Users can virtually enjoy furniture without fear of fatal errors, which takes a substantial burden off their shoulders before the significant purchase.

2) Product customization:
Prior to purchasing, users can visualize and modify the size, colour, and placement of the furniture. This way, furniture companies can help reduce customer anxiety by providing a plethora of options to test and allowing them to purchase their favourite item with a single click.

3) In-store interaction:
Companies can use AR to share information, guidelines, tricks etc. throughout the store by using digital imagery. AR is also beneficial for in-store navigation and loyalty rewards, which customers can save and reimburse whenever they please [42].
Once it will be decided to use AR technology at the stage of educating students/ training apprentices/ new employees and a study/ internship training plan will be adapted to it, it seems easier to benefit from levels of usage AR in furniture retail described above.

Mixed Reality

The potential for using MR in education in the wood and furniture industries is enormous. The applicability of MR is like VR, which was previously discussed in the report. The ability to train apprentices or students without exposing them to complex and potentially dangerous situations while still allowing them to experience them is the most significant advantage of MR technology.

360 photos and videos

The importance of having a website has never been greater for the furniture and wood sector. The proper question is how to close the online-offline gap and provide customers with compelling virtual experiences. The response can be by using 360-degree photos and videos to create aesthetically appealing product pages that simplify product visualization and save time, money, and resources. Furthermore, the probability that customers will buy a product increase with the percentage of visual information they receive about it. By providing clients with extra graphics to interact with, there is a significant opportunity to raise a company's reputation [43].

The use of visual techniques in education has the potential to encourage students to reflect on their behaviour to alter it. In addition, it helps students better understand the learning material by visualizing it. The use of visual approaches, methods, and strategies in educational settings opens fresh viewpoints and ideas [44].

Visual assistance for students or apprentices in W&F education can significantly accelerate the process of training a future skilled employee/ entrepreneur/ manager.

Some conclusions about the use of XR technologies in the Wood & Furniture sector

The W&F sectors have a great possibility to grow in the future thanks to Extended Reality (XR) and it is likely to affect both businesses (workers, experts, managers) including on-the-job training and the educational training in schools (VET/HE students, apprentices, new employees).

The W&F industry's manufacturing process has limitations that prevent the use of XR tools since it operates practically every day of the year, except for maintenance breaks, at a particular efficiency and speed. Therefore, currently, the application of XR technologies utility is limited in production and management. However, with a supposed future increase in the significance of the metaverse (virtual world), this might change from a mid- to long-term perspective.

Among the few domains for application in production is machine maintenance. For instance, the combination of a distant expert and a local worker using an XR device (AR) can result in more efficient maintenance depending on the maintenance level, especially for the lower maintenance levels. Other large domains of application of XR technology in W&F companies are obviously customer experience and relationship management (e.g., virtual simulations of products in clients' homes) as well as virtual company visits and on-the-job training programs for students, trainees, apprentices, new staff and middle managers.

In educational training in schools focusing on the W&F sector, using XR is a valuable and needs-matching solution for introducing new technologies to education programmes. Indeed, once established as a training tool, XR technologies contribute to increasing students' motivation, saving instructors working time while, reducing the consumption of raw materials and electricity. In this way, the XR technologies improve both training efficiency and effectiveness. Finally, no matter where XR technologies are implemented, it must be done coherently and consider the framework in which they are applied. For instance, in educational training in schools they will only reach the aimed results if they are adequately introduced into the `ecosystem´ of needed equipment, skills gaps of teachers and students, curricula, the reality of schools including the board of directors, the professional associations and other key stakeholders including the W&F sector and their specific needs in terms of skills for today and tomorrow. In addition to the challenge of establishing XR technologies in such an `ecosystem´, it is important to consider the national and regional level of all the factors. This means that there is no one-size-fits-all approach and that in every country or region tailor-made solutions must be developed.

Allview

4

Main learning outcomes using Virtual Reality and Mixed Reality in the classroom

4. Main learning outcomes using Virtual Reality and Mixed Reality in the classroom

The basic objective of education is to provide students with the knowledge and abilities that are considered important in society to prepare them for life, job, and citizenship. Enhancing graduates' qualifications, abilities, and skills throughout the educational process is the responsibility of the educator. The demands of students and the job market over time compelled modifications in the educational system. The practical aspect had been given emphasis in accordance with Confucius's wise maxim, "Tell me and I forget, show me and I may remember, let me take part and I understand".

Figure 29: VR and MR in education [59].

Modern technologies, including online courses, blended learning, various computer-based platforms, and others, are the current solutions. These tools allow students to repeat the same material multiple times, make mistakes, and learn from them. The EdTech industry can improve learning results for most students, according to numerous examples of technology and software that have proven successful in educational processes, such as Virtual Reality (VR) and Mixed Reality (MR) [45].

VR and MR in the classroom. SWOT analysis

A three-dimensional (3D) simulation of an actual or hypothetical system is known as Virtual Reality (VR). With the effects being produced in real time, users of such a system can frequently alter virtual items in the simulated environment. Two key terms that are frequently used to define the degree of virtuality in VR systems are immersion and presence. The former is defined as the intensity of a user's experience in a virtual world, whereas presence is a person's subjective perception of being in a place while being somewhere else [46].

Mixed reality (MR) is the integration of real-world objects into a virtual environment or, alternately, the mixing of virtual computer graphics objects into a real three-dimensional scene. In general, augmented reality refers to the first scenario, and augmented virtuality to the second. Three qualities are essential to an augmented reality interface [47]: To begin with, it merges the real with the virtual. Secondly, it presents a real-time interaction. Thirdly, it registers three dimensions.

It has been suggested that the technical advancements of VR and MR will make learning easier. The study of and use of VR/MR in education has improved teaching and learning methods in the current educational strategy. Over the past two decades, numerous studies have shown the benefits of VR and MR use in the classroom. The table below shows a SWOT analysis of the implementation of such software technologies on educational backgrounds:

SWOT ANALYSIS			
STRENGTHS	• The role of the teacher can change from the deliverer of knowledge into a facilitator who helps the students to explore and learn. • Students can learn experientially and proceed at their own pace since they are exploring a virtual environment, preventing situations where students are left behind during the lecture and spend the rest of the class trying to catch up. • Students can learn abstract concepts because they can experience and visualize these concepts in the virtual environment.	WEAKNESSES	• Several participants in virtual reality studies have felt nausea, motion-sickness, or minor headaches while using the devices. • Since most teachers do not have the time or the technical skills to create their own virtual reality applications, third parties will probably be needed to create and maintain these programs and the content with them. • There is additional time required for the students and teachers to learn how to use their virtual reality devices.

	• VR or MR learning environment fosters active learning and helps students grasp abstract knowledge in contrast with the traditional learning process which is usually language-based, conceptual, and abstract. • Low-spatial ability learners particularly benefit from VR or MR because the visualizations help lower the extraneous cognitive load of the learning objectives. • The user comprehends systems or objects that are of widely different scales. • Students are more focused and show better concentration. • Students feel empowered and engaged because they have control over the learning process.		• The additional cognitive load of learning requires teachers to build time into their lesson plans to teach their students how to use their devices. • Teachers or administrators need to procure or build the virtual worlds or simulations for their classes. • It is needed to define clear educational objectives and goals. • There are some cases where virtual reality is not the best method for accomplishing a learning objective so it is essential to look at the course curriculum and determine where virtual reality can help, and where other teaching methods are more appropriate. • It may take more time to teach a topic with virtual reality than with traditional measures.
OPPORTUNITIES	• The ability to easily change the virtual world opens new possibilities in the realm of testing and design. • VR and MX also makes it easier to test different scenarios and hypotheses because the environment can be designed to prevent extraneous variables from disrupting the test results and the experimental variables can be precisely controlled. • Their immersive nature can help block out other distractions so the students can focus on the learning objectives. • The interactive nature of VR and MR transforms students from passive learners into active	THREATS	• Reliance upon virtual reality environments adds another point of failure that needs to be planned for. • As with any computer, virtual reality devices can break or crash and the risk of any one malfunction occurring increases as more students use virtual reality devices. • It is vital to remember that virtual reality technology does not reduce the importance of lesson planning or the role of the teacher in class instruction. • Although the teacher's role with virtual reality tools typically shifts to being a coach

	learners, improving student motivation and their sense of control over their own learning. • Dangerous and rare situations can be simulated in virtual reality enabling students to learn in safety. • The advances in technology for mobile devices have reduced the size of VR devices and for some reduction in quality, mobile devices in inexpensive viewers such as Google Cardboard has made virtual reality extremely affordable. • It is needed to redesign the lesson plans from a teacher-centred, delivery-based focus to a student-centred lesson plan.		and a mentor, the teacher's guidance is still critical when using virtual reality systems. • Integrating virtual reality with a curriculum can be difficult and some teachers may be resistant to using the new technology. • If the virtual reality tools are difficult to use, this may discourage teachers from employing it in their classrooms. • Keep backup devices on hand and backup lesson plans must be present in case technical issues, Internet outages, or other circumstances would prevent the entire class from using virtual reality. • Since many teachers may not have been exposed to the capabilities or applications of virtual reality in the classroom, some form of professional education should be used so teachers feel comfortable using the technology in their classroom and exploring the new possibilities that VR opens.

Table 1. SWOT analysis of Virtual Reality and Augmented Reality in Education. [48]. Own elaboration.

VR and MX vs. students. Knowledge, skills, and competences in the classroom

The increased use of virtual reality (VR) and mixed reality (MR) has enabled learning to become more active and collaborative and allows professionals to be trained more quickly, engagingly, and effectively. However, creating this quality learning experience requires a lot of effort and, as a result, remains in the early stages of adoption. Higher education institutions are expected to increasingly adopt mixed reality in the near term, taking full advantage of technologies where digital and physical objects can co-exist. By 2030, virtual and augmented reality in education alone could contribute $1.5 trillion to the global economy.

Some of the main Learning Outcomes (K/S/C) that the student can obtain with the integration of these technologies in the classroom could be the following:

Knowledge

- Learning tasks that benefit from repetition or even simple exposure.
- Enabling students to create using materials and machines they would not otherwise have access to.
- Learning how to use new technologies.
- Improving knowledge retention.

Skills

- Work skills.
- Enhancing students' learning experiences.
- Developing transversal and specific skills, such as critical thinking in fully safe and immersive environments.
- Stimulating students' concentration, satisfaction, and motivation.

Competences

- Performing training practices in a safe way.
- Digital competences.
- Improving decision-making and problem solving.
- Encourage innovation and creativity in design, and teamwork.

Figure 30: Learning Outcomes (K/S/C) that the student can obtain with the integration of these technologies in the classroom.

*It is important to take into consideration that this technology is constantly under development and improvement and, thus, this learning outcomes are likely to change.

VR & MR and its connection to the demands of future jobs in the furniture and wood sector

There are training demands in the furniture and wood sector that require the use of complex machinery such as pneumatic staplers, edgers, sanders, planers, band saws, table circular sawing machine carriages, presses, moulders, saws, spindle moulders, digital laser printing or machining of wooden parts and derivatives with numerical control centres (CNC). Thanks to virtual reality/mixed reality, the student can practice in an immersive way with this machinery without the need to have all the machines in person, without wasting materials, without posing a danger to the student's health and without the possibility of breaking the equipment.

Some training demands require specific certifications and safety courses due to their dangerousness, such as working at heights, lifting platforms, crane handling or forklift handling. Virtual reality can help to address this training demand as it is an exposure work and can make the learner face a dangerous situation and avoid fear when applying the real work.

In other manufacturing tasks such as assembly, chipboard manufacture, melamine board manufacture and accompanying processes, furniture component manufacture, measuring techniques, use of chemicals and the implementation of new materials, virtual reality can help learners as it allows the use of materials to which they would not otherwise have access.

In other areas of learning that encompass knowledge of construction systems, joints, wood handling, wood type, plan interpretation, occupational health, virtual reality can help improve knowledge retention and the learning experience.

Many universities and higher education fields are already providing scaled-up authentic learning experiences. All of this is taking on against a backdrop of increased international pressure for colleges and universities to better train and equip students with the skills and talents they will need to succeed in both the disrupted workplaces of today and the workplaces of the future.

The Occupations Observatory of the Spanish State Public Employment Service (SEPE) [49] is a technical area whose mission is to analyse the situation, trends, and training needs of the labour market and to promote its knowledge to entities, social agents, institutions and citizens.

Therefore, research was conducted to find out which competences are currently in demand for some of the main occupations in the sector and could be taught by implementing of VR or MR applications in the classrooms.

Figure 31: Immersion stimulates the degree of involvement, leading to more efficient and satisfying learning [50].

Upholsterers, bed makers and related trades

- Measuring techniques.
- Use of upholstery machinery and tools such as pneumatic staplers.

Cabinet makers (carpenter/joiner) and related workers

- Product design and presentation software: AUTOCAD, CADCAM, Inventor, AutoCAD 2D, 3D, Solidword, Alfacam Business management and ERP (Enterprise Resource Planning) software: Navision, Contaplus, ...
- Learning to use edging machines, sanding machines, planning machines, band saws, ...
- Machining of wooden parts and derivatives with numerical control centres (CNC).
- Implementation of new materials such as sustainable and energy-efficient materials.

Installers and operators of woodworking machines:

- Types of wood.
- Wood machining.
- Handling of machinery (presses, moulders, saws, shapers).
- Occupational health.
- Computer numerical control (CNC).
- Digital laser printing.
- Implementation of new materials.

Operators of sawmills, panel making machines and related installations for the processing of wood and cork:

- Use of chemical products.
- Operation of machinery (presses, moulders, saws, spindle moulders).
- Computer numerical control (CNC) (automation of machine tools).
- Digital laser printing.
- Occupational health.

Wood processing workers:

- Knowledge of construction systems, joints, wood handling.
- Assembly.
- Training on the circular sawing machines with carriage
- Interpretation of plans.
- Handling of forklift trucks.
- Handling of cranes.
- Machining of parts: CNC numerical control.
- Lifting platforms.
- Working at heights.
- Joints in situ.
- Advanced AutoCAD for wooden structures and beam machining: CADWORK.
- Production processes: manufacture of chipboard, manufacture of melamine board and accompanying processes. Manufacture of furniture components.

Allview

5

Integration of VR and MR Technologies in the classroom activities within VET courses

5. Integration of VR and MR Technologies in the classroom activities in VET courses

Virtual Reality (VR) and Mixed Reality (MR) technologies are rapidly gaining popularity in various industries, including education. In the context of vocational education and training (VET) courses, the integration of VR and MR technologies can provide numerous benefits for learners. This integration can transform traditional classroom activities into immersive and engaging experiences, enabling learners to develop practical skills and competencies in a safe and controlled environment. Additionally, the integration of VR and MR technologies can help to address some of the challenges faced by VET institutions, such as limited resources, accessibility issues, and the need for more flexible and personalized learning experiences. This section explores the various ways in which VR and MR technologies can be integrated into classroom activities in VET courses, highlighting the benefits, challenges, and best practices associated with this approach.

Virtual Reality

It is possible to implement the use of VR headsets in the process of practical subjects teaching, as a smart solution for avoiding moments in which the laboratories are overcrowded, and students must wait in line to use a machine.

Students can access the VR experiences through a free to use viewer software (SimLab VR Viewer) in two different ways: by using a VR headset (Pico Neo 3 PRO) in dedicated areas (school common areas, spare classrooms) or by accessing the software with a PC and navigating the simulation in the same way as a “first person” videogame is played, during those moments designated to simulating and revising practical procedures and theoretical notions.

An introductive lesson would be necessary, to give students, the basics of how to use the software and to run the simulative experiences: the introduction to the PC version of the software can be performed in the IT classrooms. In a dedicated area, students are shown how to use the VR headset: at first the teacher wears the headset, and the virtual experience is screencast to a TV with a compatible app (Miracast) or a Windows 10 PC supporting the app.

After attending the introductive lesson, students receive a token or certificate: this will allow them to have access to the VR headsets and pick them up from the storage area, while signing in on a register for the school to keep track of the device’s users.

Figure 32: XR Expo 2019: exhibition for VR, AR, MR and XR [60].

An example of the integration of VR headsets and VR viewer software on PC, in the classroom, is a lesson focused on CADCAM programming and subsequent use of the laboratory machines, for preparing raw material and running the CNC program. After programming in the IT room, it is possible to dedicate a given amount of time to reviewing the main procedures related to the following laboratory activities. Each student can access the simulation on his PC viewer software, while a few are allowed to also test the procedure via VR headset. After this, the class moves to the lab to practically perform the tasks.

It is important that the virtual experiences can also be available to the students from their home PC, during those moments of the year during which it's not possible for them to access the laboratory. Each student would be able to download and install the free to use viewer software, register an account and receive an invitation to play the VR simulations shared by the school.

The most time and effort demanding aspects of integrating VR technology in the curriculum seem to be the production of 3D models and the simulations programming.

Since designing and 3D modelling classes are already present in the CV of most VET schools of the sector, the students would be part of the development of 3D assets libraries: while learning basic and advanced 3D modelling, they could produce the objects that will then become part of the VR simulations.

Theoretical Classes

As part of theoretical lessons about Materials Technologies, it is possible to use the VR headset to observe the different materials on which the lesson is focused (solid wood species, wood-based panels, plastic coverings, minerals, finishings, hardware): students can review their knowledge by accessing materials libraries with textures and technical specifications. This is possible both with a VR headset and a PC, at school in the IT classrooms and dedicated areas, as well as at home. At the end of the materials examination, or to get to a next step in the virtual experience, a self-evaluation quiz would let the students verify their understanding of the topic. During Furniture Design lessons, students can observe and interact with the 3D functional model of a specific piece of furniture, both with VR goggles and PC viewer, autonomously or with the teacher's guidance. It's possible to interact with the cabinet's moving parts, to explore components and hardware, to consult technical data sheets and learn about the production process and assembling steps needed to get to the finished product.

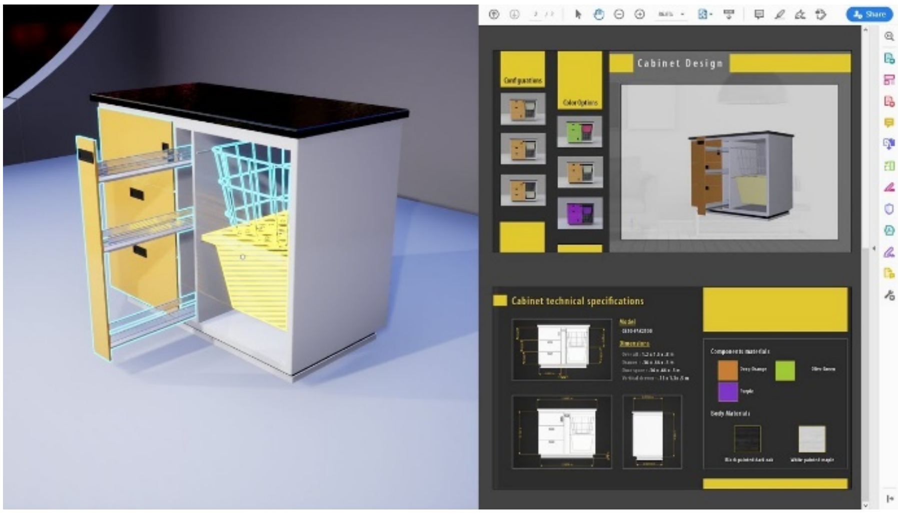


Figure 33: Cabinet design [51].

Another instance where this technology could be applied is in the ability to thoroughly examine and analyse the 3D model of seating arrangements and furniture placement, placing particular emphasis on ensuring adherence to standard dimensions, ergonomic principles, safety regulations, mechanical features, and materials used, to optimize the overall design and functionality of the space.

Practical Classes

The use of VR headsets and PC viewer software allows a safe first approach to dangerous machinery, while reducing the risk of injuries and laboratory overcrowding. It is possible for the students to use VR technology to learn about and get familiar with specific material machining operations, tool handling, machinery maintenance and components assembly into a finished product.

It is also possible to create cooperative VR experiences which allow multiple students to interact in real time in the same VR simulation: this is useful to review and test their knowledge about procedures that require two or more operators, such as materials handling, raw material machining, machinery maintenance.

Being able to break down a complex operation, into several basic steps, makes the learning process easier and faster. The goal with VR simulations is to provide guidance through a series of steps which are to be so intuitive as to be trivial: by repeating the simulations, since the students are playing with the content in a familiar virtual environment, the amount of perceived effort needed to acquire information is reduced.

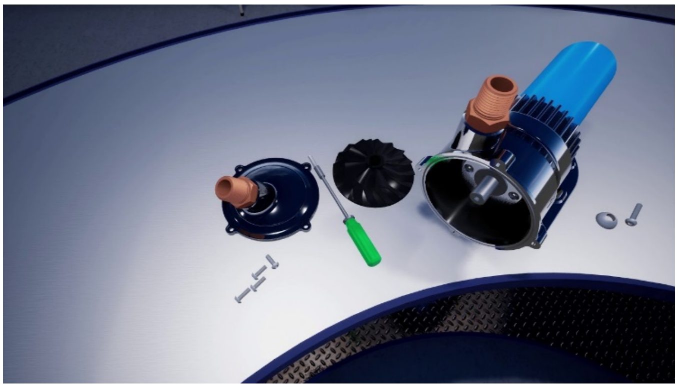


Figure 34: Virtual Reality Simulation [52].

Example: introductive lesson about machinery

The first part of the lesson, in the classroom, is focused on introducing a specific machine and the operations that can be carried out with it. As the teacher explains the basics of the machine, students can verify the information by using both VR headsets and the PC viewer. After this theoretical and virtual introduction, or during the following lesson, the class moves to the laboratory for a practical first approach to the machinery: students will already have acquired some basic knowledge and will be able to quickly get familiar with the machine's safety and operational features.

Example: use of machinery in the laboratory

As it often happens, the class carries out the given task and all the students need to go through the same production steps. Schools' laboratories offer an insufficient number of machines of the same kind, compared to the number of students per class. This leads to overcrowding of the work areas and students must wait in line for using the machinery.

While a group of students can work with the practical tools, the rest of them can gather in a designated area or in the IT rooms and virtually perform the same operations with VR headsets and PC viewer software.

Another opportunity for a student who doesn't remember the full operational procedure, is being able to stop the practical activity, get to the VR or PC area and revise the given task step by step, without having to wait for the teacher who may be supervising the other kids working on the machines. This creates an environment in which students learn problem solving and self-management on the workplace.

Several kinds of machinery, tools, production processes, maintenance operations and safety procedures can be introduced, explored, and revised using VR simulations.

Example: Preparing and operating a table circular sawing machine with sliding table

The simulation provides information about the safety features of the machine, PPE needed, handling, and adjusting the machine's moving parts, choosing the correct kind of saw blade needed for machining solid wood or wood-based panels, face grain cutting and cross cutting, additional steps needed to perform other operations.

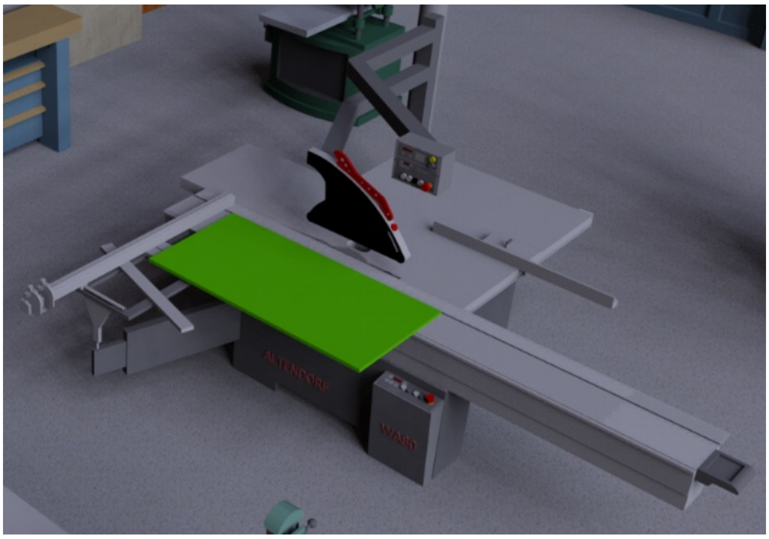


Figure 35: Altendorf circular sawing machine in VR.

Similar VR experiences can be developed and focus on preparing and operating surface planers, thickness planers, edge banding machines, boarding machines and different kinds of machinery needed for finishing the components.

Even though some equipment is composed of multiple operating tools, it would be possible to produce simplified 3D models of the external shell, operating screens and panels, buttons and moving parts.

By integrating simple or simplified 3D models in the VR experiences, it's possible to repeatedly simulate several kinds of assembling procedures: assembling tools and furniture is a time and space consuming activity, it's uncommon that the whole class can practically perform these tasks. By implementing VR headset simulations, each student can go through the procedures, practically or virtually.

This way different exercises can focus on recognising and picking up, mounting, and dismounting CNC or machinery tools, recognising furniture components, and assembling them into the finished product.

Safety Classes

During safety classes about the use of specific PPE, after a theoretical introduction or while the teacher is guiding the class, students can observe and pick up the PPE with VR headsets and PC viewer software.

Figure 36: Picking Personal protective equipment with VR [53].

Similarly, a few minutes can be devoted to reviewing the topic just before taking the class to the laboratory: exercises about recognising a machine's integrated protection devices, matching PPE with a machine, procedure or working area, allow to verify that the students have a basic understanding of how to safely perform practical activities.

Furniture Design Classes

After completing the drawing and 3D modelling steps for a project, students can use VR headsets and PC viewers to furnish a virtual environment with their own creations, while considering their knowledge about safety, ergonomics, and standard measurements.

During lessons about specific interior environments, VR simulations can be used to observe a furnished area, interact with the furniture, investigate the components and their functionality, change materials and finishings, choose which furniture to hide or show in the room as well as to modify the arrangement of furniture.

Figure 37: SimLab Virtual Reality Viewer.

360° VIDEOS – VR

The implementation of 360-degree videos allows the mapping of laboratories for the creation of tours and navigable paths, by wearing VR headsets or via desktop PC: students move in the photographed or rendered virtual space by selecting subsequent photographic steps.

Figure 38: Tour 360 video.

The navigable environment can be captured by a 360° camera and faithfully represent the appearance of the laboratory, with the possibility of elaborating exercises based on the selection of the path to be followed, which corresponds to the correct workflow through the machines, to obtain a finished product from the raw material.

Within the tour it is possible to place interactive elements at each step of the path: students can consult technical sheets related to the products or processes represented; summary questions can pop up, to verify that the student has acquired the basic knowledge to move to the following step; It is possible to request the selection of the following step and then verify that the student is able to recognize the correct workflow, for example by moving to the machinery suitable for the processing to be performed.

Interior Design and Marketing Classes

Example: Virtual showroom

The navigable environment, in this case, can be entirely produced through 3D modelling and rendering. It is possible to reproduce exploratory tours of furnished environments and showrooms in which to place products and models from catalogues or objects produced by students.

Theoretical and Safety Classes

Example: Laboratory workflow

At the start of the interactive tour, students are required to select the kind of material to be processed and the result to be obtained. Then the exercise requires to follow the correct path between the machines to perform the different operations. When passing between successive stages of processing or material handling, it is also necessary to identify the PPE suitable for the operation.

For example, if a solid wood object is selected, the student must be able to identify and select the area from which to pick the boards and define the PPE needed (shoes, gloves, mask). Then the first machine to be used for the roughing of the material needs to be selected and it is verified that this corresponds to the appropriate processing phase. Students can consult technical sheets about the machine or operation to be performed, in text, audio or video format. They are then asked to order the sequence of actions to be performed on the machinery. Finally, it is required to choose the following steps and working areas and so on, until the workflow required is completed.

MR – Mixed Reality

Mixed Reality experiences become particularly useful when integrated in the production process. The MR headset provides real time assistance, guiding students during the execution of machining operations as well as in solving technical issues with the machinery.

Mixed Reality, through tools such as Microsoft HoloLens 2 headset and Microsoft Dynamics 365 Guides software allows to create exercises, "guides", bound to the real environment in which the tasks will be performed.

Students who have previously received a practical introduction to the machinery, are then able to use these guides to autonomously operate the machine, perform maintenance tasks, manage tools, or assemble components into a finished product. The added value of MR headsets, when used in the working environment, compared to VR technology, is the possibility of reviewing the correct procedure while it is being carried out by the student: the headset provides practical guidance for the motion of the operator, theoretical and technical information through videos, text, and images about the subject of the guide.

Figure 39: Mixed Reality with HoloLens [54].

An introductive lesson about the use of MR technology needs to be scheduled: MR headsets are expensive and it's not possible for each student to wear one at the same time. It is though possible to stream the content of the headset, so that both the real world and the projected 3D holograms are visible on PC and TV screens. Each of the students will eventually wear the MR headset but, while waiting for their turn, they are able to get familiar with the basics of the technology by watching their classmates or the teacher's streaming.

MR experiences are a tool for boosting the learn-by-doing process but also a way of assisting the teacher in better handling the class: students who need to be guided don't have to wait for the teacher to be available, they can try and solve a situation by wearing the MR headset and loading the pertinent guide.

To integrate the use of MR guides in classroom and laboratory activities, there is no need for designated areas since the MR headset allows students to access the content in the actual working environment.

The guide is linked to the presence of a physical object, a QR code or similar, which can be placed in the real world and will function as the origin point of the experience. The relative position of machinery, tools and working areas is memorized by the headset, during the creation of the guide.

Since the exercise or activity is carried out in the actual working environment, conversely to VR technology, with MR it is not necessary to produce big amounts of 3D models: machines, working areas and tools need to be placed in the memorized position so that the visual prompts (holograms) can be projected onto them.

Some amount of 3D modelling is required to produce specific assets that are then going to be used as holograms, 3D shapes that are projected through the screen onto the real environment for showing the student the appearance and position of the object that needs to be picked up, where a component must be placed or how a tool has to be oriented and used.

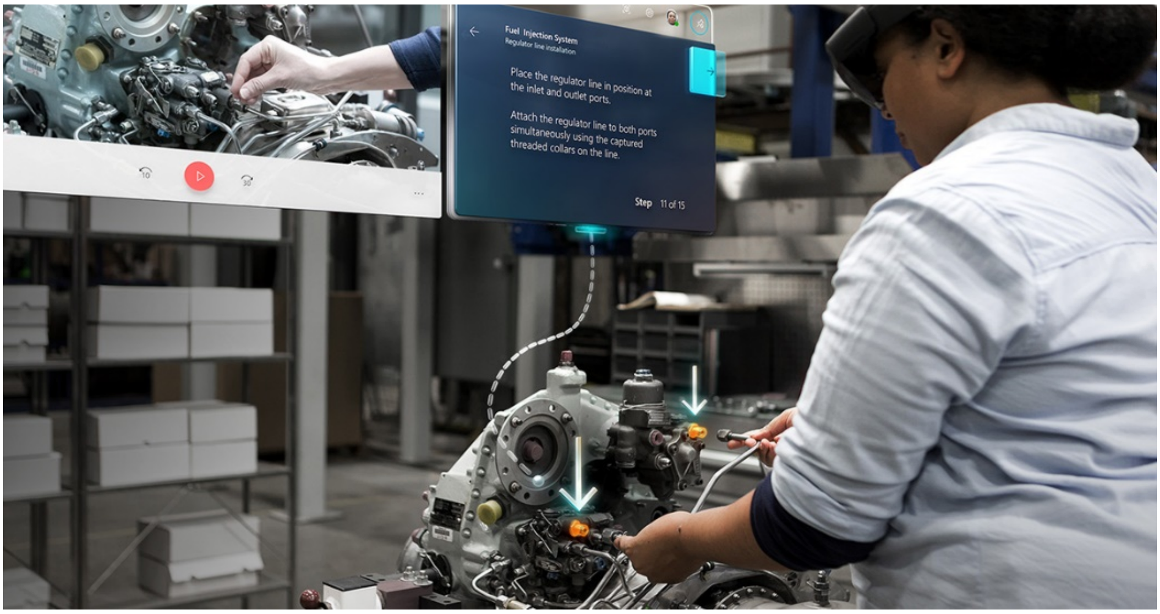


Figure 40: Incident resolution with HoloLens and Mixed Reality [55].

The remaining visual prompts are indicators, arrows, glowing or pulsing areas, which can be selected from a pre-existing asset library and are necessary to guide the students' motion.

The student moves through the steps of the MR guide thanks to the headset's ability to recognise when the operator places his hand in the area from which a tool needs to be picked up or in which a gesture or procedure needs to happen. The operator can also pinch a holographic button with his fingers or focus the MR headset's sight on the button for a few seconds.

It is important to consider than not the sight nor the movements of the operator are limited by wearing the MR headset, which makes this technology safe and useful during practical activities and production procedures.

Practical Classes

Example: Assembling Furniture

MR guides can be implemented during laboratory activities, allowing additional support for carrying out assembly procedures so that the students can start from the previously machined components and put them together into a finished piece of furniture.

While the teacher guides a group of students, the MR headset is available for those who need to carry out the given task but should otherwise wait for the teacher, who is of course nearby, to become available.

When assembling of a cabinet with the aid of MR guides (developed by Belgian partners) students need to pick up the components and joinery, putting them together in the correct order. In order to make this type of exercise readily accessible, a wall system or more flexible panel system should be set up. This allows to place components and tools in an orderly and reproducible way. The QR code, functioning as the origin point of the guide, needs to be placed on the wall system as well and the MR headset will then be able to orient itself and let the students start following the first step of the guide.

MR guides can be quickly developed, especially in the case of exercises focused on procedures that can be broken down to a few simple steps: this means that several guides may become quickly available for assisting the students in safely preparing and using each laboratory's machine, as well as performing routine maintenance and solving problems related to the machinery.

During any laboratory activity focused on machinery, the MR headset can be available for guiding in the actual machining procedure, as well as for carrying out all those additional activities needed for keeping a safe work environment, such as activating the chip and dust suction systems connected to the machines.

Management of complex machinery

Practical lessons for CNC operators are an example of effective and articulated MR guides implementation: considering the required investment, the number of operational procedures and the possibility of running into technical situations, CNC machines are particularly suitable for MR assisted problem solving.

MR guides can offer support to the students while performing standard procedures on the machine: turning on the machine, loading a program into the control panel, setting up and placing the CNC's moving parts as well as the raw material, starting the execution of the program and handling the machining phases.

Maintenance procedures can be guided by the MR headset as well: discharging the machine's tools, cleaning tool chambers, pumps, and filters, greasing moving parts and maintaining the spindles are all operations that can be easily broken down to simple and intuitive steps.

Figure 41: Technical Troubleshooting with HoloLens [56].

Solving technical issues with some degree of assistance is an important contribution of MR technology. During CNC practical lessons, several situations can happen, and specific error alerts are shown on the machine's control panel. With the assistance of trainers and teachers, it is possible to develop guides for solving each of the most common reported errors: in case of a situation, students would then be able to identify the alert code, wear the MR headset and load the troubleshooting guide in order to safely reset the machine and get back to operating it, instead of having to wait for the trainer to be available. These guides would allow a certain degree of autonomy in the use of the machinery and would also provide theoretical and practical insights about the probable cause of the most common errors that can occur when using the machine.

Similar application may have guides created to help students in the use, operation, and maintenance of machines in areas of rapid prototyping, such as 3D printers, laser cutters, and cobots.

During a 3D printing prototyping lesson, at the end of the programming phase with slicer software, students begin to prepare the printers. This is a situation where it is likely that many students have the opportunity to use different machines at the same time: the teacher can follow only a few at a time, so others can wear the MR headset and use the guides to proceed to the printing phase.

Safety Classes

The use of MR guides can be implemented during theoretical and practical lessons on safety focused on the different working areas of the laboratory.

Being in front of the machine, students can review the PPE to wear before approaching the machine, see highlighted the protective devices integrated into the machinery, test their trigger, and reset procedures.

The guides require that a starting position of the components of the machine is memorized: this must be replicated at the start of the guide, to allow the MR viewer to correctly project the information on the machine.

It's possible to locate and set emergency buttons, blade coverings, activate and deactivate the brakes of the tool holder shafts, place the suction hoods and accessories on machinery such as radial saw, surface, thick planer, band saw, square saw, panel saw, toupees, drilling machine and finishing machines.

On CNC machines students can learn to identify the perimeter safety mechanisms (carpets, cables, bumpers, photocells), the emergency buttons on the machine body, on the control panel and on the mobile controller, and learn how to reset the machinery starting from an emergency setup.

The MR headset can guide students in the correct load handling modes: a video guide shows the correct type of movement for picking, moving, and supporting heavy blocks, large panels, dangerous tools, while holograms can indicate the operators where to place their hands and how to orient the heavy load in the surrounding area.

Furniture, Interior Design, and 3D Modelling Classes

During interior design lessons, at the end of the design phase, students can wear the MR headset for measuring the environment to be furnished, placing 3D models and furniture in the space, customizing the environment by changing the layout of the furniture, materials and finishes and verifying that the rules of ergonomics, dimensions and safety are respected.

Figure 42: Interior design with MR [57] .

At the end of lessons on 3D modelling, students can observe and share with their classmates their models: check their appearance in the environment where the MR headset is worn, explode the model into components and show any functionality of the designed object.

Figure 43: Prototype visualisation [58].

The visualization of 3D models, designed with common 3D modelling software, allows to develop the ability of observation of geometric properties and stimulates moments of mutual comparison between students.

Allview

6

Integration of Allview exercises in teaching methodologies in the furniture and wood sector

6. Allview Exercises

The 10 exercises developed for task T3.3. MR, VR, and AR Toolkit - Exercises are described below. For each of them, the immersive experience, training specifications and technical specifications are presented.

Virtual Reality Application. Immersive experience involving 4 exercises. Ergonomic Furniture Design.

INFORMATION

Exercise Name	Ergonomic furniture design. Immersive experience.
Specific Subject	Furniture design and ergonomics.
Theme (Short explanation of its use)	This immersive experience consists of 4 exercises through which the student will acquire knowledge about dimensions, design tips, techniques, and materials for ergonomic furniture design.

EXERCISE 1: FURNITURE FOR DOMESTIC USE – DINNING TABLE. DESCRIPTION.

Recommended dimensions:

- Seat height: 41 – 43 cm.
- Seat depth: 40 – 42 cm.
- Seat width: 46 -52 cm.
- Seat inclination: 3o – 5o
- Height lumbar support: 15 – 17 cm.
- Seat-Back angle: 100o – 105o cm.
- Back height: > 42 cm.
- Free angle under seat: < 60o

- Table height: 69 – 73 cm.
- Table-Seat height: 30 – 32 cm.
- Free height under table: > 65 cm.
- Free depth under table: > 45 cm.

Design advice:

- Seats without cushion must not have reliefs or pronounced shapes, because, however comfortable it may be in a certain position, it would not allow to change the position. Since they are multipurpose chairs, a soft relief can be accepted, being a small hollow in the buttocks zone, with a certain elevation in the back part of the seat and leaving it flat in the thighs zone.
- In cushioned chairs, fills must be consisting of and with a firm basis. Very soft seats reduce mobility and cause anomalous pressure distribution, focusing charges in sensitive zones.
- In very high seats, user suffers compression in thighs. If it is too low, the support surface on the seat is reduced, and the angle of hip flexion closes, suffering compression of abdomen and pressure on buttocks.
- Excessive depth causes low users not to use lumbar support, for avoiding pressure on the hollow of the knee. A poor depth restricts the support surface of thighs and buttocks, which means greater pressure. The lower the seat, the lower risk of compression in the hollow of the knees, and the seat can be deeper.
- Seat angle constrains the task. For table tasks, such as eating, writing, etc., a seat angle near to horizontal is required, and for more relaxation, a gradual backward inclination of the backrest is imposed, which also implies seat inclination.
- Backrest must cover from the maximum lumbar concavity of the back to the bottom part of the shoulder blades, or even higher for uses closer to resting chairs. If the backrest reaches the seat, it should have a concavity zone for accommodating the back area of the buttocks. Backrest must not have sharps edges, narrow bars or other elements that stick in the back.
- The lower the angle of the backrest, the more the seat angle should be inclined. For big seat-backrest angles, height of the lumbar support should be reduced. An exclusively lumbar backrest is, generally, too low, unless the chair has a very specific use for table

work. However, it can be adequate in quite upright postures, for short times since it allows the movement of arms in active postures.

- Chairs must be stable. It is preferable to avoid three legs chairs, or with a small effective basis, which represent tipping hazard.
- If the chair does not have armrests, the only design criteria is the seat, which must not be too small for a user with a very large hip. If there is an armrest, a gap between hips and armrest must exist. The criteria are, that users can properly lay the arms, unloading the weight of these without lifting the shoulders. For that, armrests must be placed at the elbow's height.
- Another criterion is that users with larger hips can be seated without being compressed, and that users with less distance between elbows can be correctly laid without the need of a great arms separation/It is advisable to keep the armrests parallel to the seat. It is also important that armrests do not interfere with tables.
- High tables are forcing users to rise shoulders for reaching the working area. Low tables generate postures with a very flexed body.
- Enough space for knees must be under the table. It is advisable to avoid sleepers and other elements that represent risk impact. Position must be able to be changed freely.

Techniques and materials:

- Dining tables generally consist of the following elements: four legs, two long skirts, two short skirts and a top. The manufacturing plans or templates for each of these elements must be available.
- Boxes for furniture assembly can be made with hollow chisel mortisers, chain mortisers, round mortisers, oscillating mortisers or dowel boring machines. In the furniture industry, for the finish of a table, the following types of varnishes are commonly used: polyurethane-based varnishes, cellulosic varnishes, and amino plastic varnishes. Depending on the kind of furniture, the desired appearance, or its composition by elements, considering a certain finish cycle and a certain type of varnish will be key. The finishes can be organised in chains with many variants. The figure below shows an example of a chain using mechanised trolleys.
- The basic wooden dining chair usually consists of the following elements: back legs, front legs, front skirt and its lower reinforcement, backrest and its trusses and

reinforcements, and the side skirts and their reinforcements. These elements are usually joined by mortise and tenon. The figure below shows the most basic form of mortise and tenon.

- In metal frame chairs, complex shapes are achieved by bending the metal tubes or rods and joining them by welding. Bending is carried out on special machines and many factors, such as the ductility and thickness of the material and whether it is a solid rod or a hollow tube, affect the handling and programming of the machine.

Content evaluation:

- Which of the following dimensions would be within the correct range to define the free gap between the table and the seat surface of the chair?
- 25 cm., 30 cm. o 35 cm.
- Indicate whether the following statement is correct or not: Should a chair used at a dining table always have an angle between the seat and the back bigger than 95º?
- Indicate whether the following statement is correct or not: Does the height of the table measured from the top surface to the ground must be between 69 cm and 73 cm?
- Which of the following types of varnish for furniture finishing does not correspond to one of the used for the furniture? Polyurethane-based varnish, amino plastic varnish, amino acid varnish.

PRESENTATION OF THE EXPERIENCE

It is about an immersive Virtual Reality experience where the student interacts in a completely virtual environment with a dining table - chair set. The student discovers information as he/she interacts with the elements of the scene through system controls. The information is shown to the student through the HMD.

TEACHING SPECIFICATION

What is the experience intended to teach the student? Description of the learning scenario.

The student will find himself in front of two furniture elements that are closely related to each other. Through the interaction with these elements, he/she will discover information and advice about ergonomics, manufacturing, dimensions, finishings, etc.

At all times the student is related to the furniture elements in real scale, where not only abstract information of magnitudes and data is shown, but it can be observed it in a much more tangible way, establishing the relationships between the elements that make up furniture on a human scale.

Through this exercise, the student will acquire a general knowledge of the most important aspects when designing or producing this set of furniture pieces.

What methodology can be used for its integration into the classroom/curriculum?

It is totally applicable in training methodologies based on gamification, and it has a special application through a project-based methodology, using, in this case, a design problem for the furniture elements on which the application provides information. Students would use the application to investigate what relationships or considerations need to be considered to obtain a suitable design.

What benefits can be obtained with its use?

It allows access to realities that may be inaccessible in many cases in the absence of Virtual Reality, either due to the physical impossibility of having that reality, due to economic cost or distance. The students will interact in a total immersion environment with the two pieces of furniture, in a quasi-tangible way and on a human scale, very similar to as if they were really interacting with physical objects, thus helping to fix their attention.

The acquisition of information is done through a gamified process, closely related to recreational activities, which further reinforces the attention and concentration of the student. The information is shown through the interaction with elements located in specific areas of the furniture, causing a relationship to be generated between the information provided and the place on which it is reported, helping the student to establish these relationships.

GRAPHIC DESCRIPTION

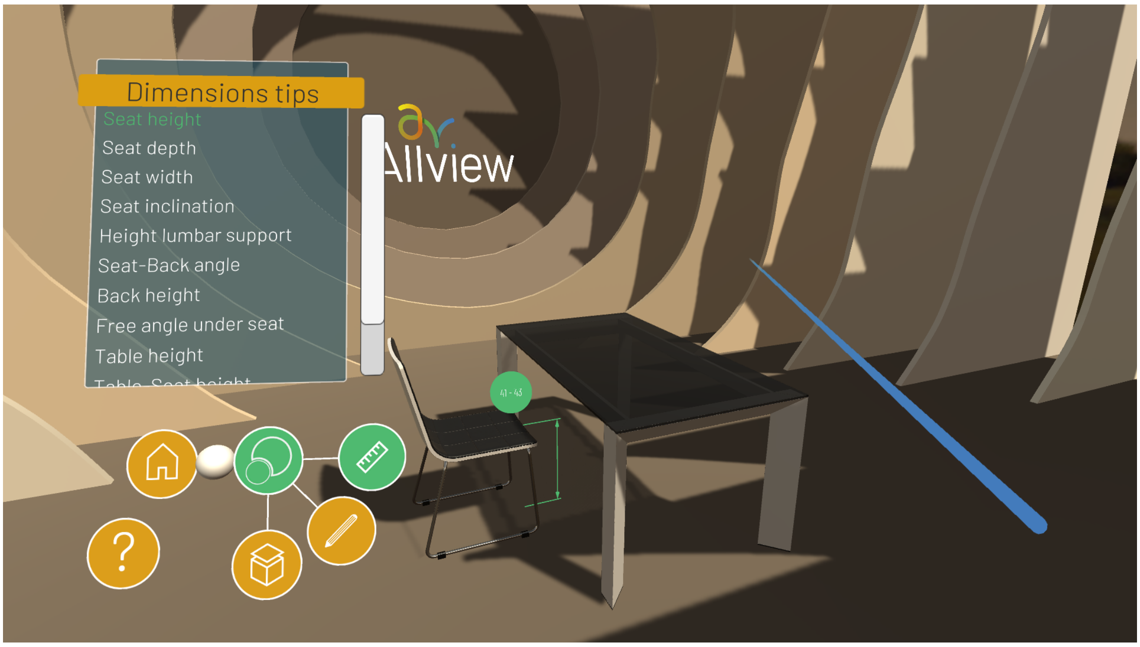


Figure 44: Dimension tips Exercise 1.

EXERCISE 2: OFFICE FURNITURE - CHAIR. DESCRIPTION.

Recommended dimensions:

- Seat height: Adjustable = 38 – 54 cm. / Not Adjustable: 41 – 43 cm.
- Seat depth: 40 – 44 cm.
- Seat width: > 40 cm.
- Seat inclination: Adjustable = -5o to 8o / Not Adjustable: 2° to 4°
- Height lumbar support: Adjustable = 15 - 25 cm. / Not Adjustable: 19 - 21 cm.
- Width lumbar support: < 35 cm.
- Width upper back part: < 30 cm.
- Height upper edge back: > 45 cm.
- Lumbar radius: 40 cm.
- Armrest height: Adjustable = 19 - 25 cm. / Not Adjustable: 21 - 23 cm.
- Distance between armrest: 46 – 52 cm.

- Armrest width: 5 cm.
- Armrest length: 22 cm.
- Armrest position: 10 – 15 cm.
- Seat-back angle: Adjustable = 100o to 120o / Not Adjustable: 105°

Design advice:

- The seat must have a cushion quite firm so that when pressing with the thumb, the support plane is not touched. For the backrest, a softer cushion is recommended. The used material must allow a good moisture and heat dissipation. They should not be used sliding materials and pronounced reliefs.
- The preferred seat inclination usually is of small rearward angles, but because of the wild range of work postures on the table, it can be alternated with forward inclinations. For that reason, it is advisable for it to be adjustable.
- The adjustment system or dynamic adjustment is advisable in multipurpose office chairs, in which the user is frequently changing his posture. This system mainly concerns to the inclination of the backrest, and it allows its automatic movement. It also adds versatility to the chair.
- For reclining backrests or seats with dynamic adjustment, it must be considered that when the backrest is folding down, the user leans a bigger proportion of his weight on it.
- Whatever the backrest inclination adjustment system is, user must be able to set the angle he/she likes the most, even blocking the movement. This does not mean that in blocked positions it exists some mobility of a little angle.
- Backrest must provide support the lumbar and thoracic zones of the back and it must remain a gap for the buttocks. It must not be too wide in its upper zone, so it does not subtract mobility to the arms.
- The chance of up and down the backrest in a wide range is advisable, so the lumbar height can vary, and the chair can be adapted to an use of a lot of hours for a single user, and to different users.
- Armrests are always advisable to give support and rest to shoulders and arms. Due to the wide range of activities in the office work, they are necessary in a lot of situations.

- To ensure stability in any user position, chairs must not have less than 5 support arms on the floor.
- In these chairs, user reaches to drawers, extra tables, etc. It is interesting to have wheels and the chance of rotate. Wheels must have some friction system that avoid excessive slide.

Techniques and materials:

- The two main components of an office chair are the seat and the backrest, as they support the back, spine and buttocks and are subject to a high wearing down. Materials such as fabrics, natural leather or synthetic mesh are commonly used to make the chairs and should be breathable and insulate against cold and heat for long periods.
- A common component in office chairs is the lever mechanism, which is responsible for adjusting the seat height and for adapting the chair to the user's movements and weight. Depending on the type of mechanism used, different levels of configuration will be offered to the user.
- The gas spring is the main component that allows the office chair to adjust in height. It consists of two concentric cylinders that make up two chambers, one of which empties the gas contained in it when activated by the lever mechanism, pushing a plunger that causes another cylinder to rise. The quality of this element determines the service life of the office chair.
- In this type of chair, the interior of the seat is usually made of moulded foam or mould-injected foam. As the latter process is highly technical, it offers great productivity.

Content evaluation:

- Which of the following dimensions is correct for the length of the armrest? 12 cm, 22 cm,27 cm?
- Indicate whether the following statement is correct or not: The range of seat height in office chairs varies according to those that can be adjusted in height and those that cannot.
- Is it correct to design an office chair with 4 wheels? Justify the answer.

- Indicate whether the following statement is correct or not: The main component of the chair lifting system is a helical spring.
-

PRESENTATION OF THE EXPERIENCE

It is about an immersive Virtual Reality experience where the student interacts in a completely virtual environment with an office chair. The student discovers information as he/she interacts with the elements of the scene through system controls. The information is shown to the student through the HMD.

TEACHING SPECIFICATION

What is the experience intended to teach the student? Description of the learning scenario.

The student will find himself in front of an office chair, and through the interaction with this element, he/she will discover information and advice about ergonomics, manufacturing, dimensions, finishings, etc.

At all times the student is related to the furniture elements in real scale, where not only abstract information of magnitudes and data is shown, but it can be observed it in a much more tangible way, establishing the relationships between the elements that make up furniture on a human scale. Through this exercise, the aim for the student is to acquire a general knowledge of the most important aspects when designing or producing this kind of office furniture.

What methodology can be used for its integration into the classroom/curriculum?

It is totally applicable in training methodologies based on gamification, and it has a special application through a project-based methodology, using, in this case, a design problem for the furniture elements on which the application provides information. Students would use the application to investigate what relationships or considerations need to be considered to obtain a suitable design.

What benefits can be obtained with its use?

It allows access to realities that may be inaccessible in many cases in the absence of Virtual Reality, either due to the physical impossibility of having that reality, due to economic cost or distance. The students will interact in a total immersion environment with the two pieces of furniture, in a quasi-tangible way and on a human scale, very similar to as if they were really interacting with physical objects, thus helping to fix their attention.

The acquisition of information is done through a gamified process, closely related to recreational activities, which further reinforces the attention and concentration of the student. The information is shown through the interaction with elements located in specific areas of the furniture, causing a relationship to be generated between the information provided and the place on which it is reported, helping the student to establish these relationships.

GRAPHIC DESCRIPTION

Figure 45: Design tips Exercise 2.

EXERCISE 3: FURNITURE FOR DOMESTIC USE - SOFA. DESCRIPTION.

Recommended dimensions:

- Seat height: 36 – 40 cm.
- Seat depth: 45 – 48 cm.
- Minimum seat width per user: 45 cm.

- Seat inclination: 15° to 25°
- Seat-Back angle: > 105°
- Back height: > 55 cm.
- Armrest height: 15 – 23 cm. from seat.
- Armrest width: > 5 cm.
- Armrest length: 35 cm.
- Armrest inclination: 0° to 5°
- Seat width for 2 people: 100 cm.
- Seat width for 3 people: 155 cm.
- Seat width for 4 people: 210 cm.

Design advice:

- The traditional sofa usually has some ergonomic deficiencies. It can be found too deep, too low, or too soft sofas. Or also that users interfere with each other if the width is not enough.
- Excessive depth favours slumped postures. But if depth is poor, users have short thighs and buttocks support surface, which means greater pressure and less comfort.
- When dimensioning the widths, it must be considered not only the necessary anthropometric width for single-seat chairs and armchairs, but also a greater value, which allows the freedom of movement of users, without interferences.
- Backrest must consist of a convex support at the lumbar level, and it must have a soft concave shape at the thoracic vertebrae height. In addition, it is advisable to leave a concavity between the lumbar support and the seat, where buttocks can be placed without pressure.
- For great backrest angles, the headrest improves considerably the postural comfort of the cervical rachis. It is advisable to be height-adjustable since a wrong positioned headrest is a source of great discomfort. For maximum comfort, if the seat is horizontal, the angle between the seat and the backrest should be greater than 125°. If the seat is gradually inclined, the same level of relaxation is achieved with smaller angles.
- The traditional sofa usually has some ergonomic deficiencies. Such as user does not have an armrest, or both.

Techniques and materials:

- The structure or skeleton of the sofa, which is made of wood or metal, is key to ensuring its durability. It may have elastic webbings, which can be made of metal or fabric.
- To guarantee a good finish, the patterning and sewing of the fabrics or leathers that cover the sofa must be of high quality and very resistant. The fabric cutting process is currently highly technical and supported by software tools that optimise both the use of materials and manufacturing times.
- One of the most important stages in the manufacture of a sofa is the upholstery and filling of the fabrics. Staples are usually used to join the upholstery to the structure and specific glues are used for the foam rubber to do the same. In addition, the cushions are filled with polyurethane foam and fibres. Nowadays, most beds used in hospital environments are designed to carry patients. For this purpose, casters are a key component to be considered when manufacturing hospital beds. To choose the right supplier, casters should swivel correctly, overcome certain obstacles, and offer ease of movement and quiet operation.

Content evaluation:

- Which of the following values would be the correct one to determine the angle formed by seat and backrest? >105°, <105°, <90°.
- Indicate whether the following statement is correct or not: The dimension corresponding to the width of the sofa is established exclusively from the anthropometric dimension of a seated person.
- Indicate whether the following statement is correct or not: The durability of the sofa depends to a great extent on its internal structure or skeleton.
- Which of the following dimension ranges would be correct for the sofa seat depth? <45 cm, between 45 and 48 cm, between 48 and 52 cm.

PRESENTATION OF THE EXPERIENCE

It is about an immersive Virtual Reality experience where the student interacts in a completely virtual environment with a sofa. The student discovers information as he/she interacts with the elements of the scene through system controls. The information is shown to the student through the HMD.

TEACHING SPECIFICATION

What is the experience intended to teach the student? Description of the learning scenario.
The student will find himself in front of a sofa, and through the interaction with this element, he/she will discover information and advice about ergonomics, manufacturing, dimensions, finishings, etc.

At all times the student is related to the furniture elements in real scale, where not only abstract information of magnitudes and data is shown, but it can be observed it in a much more tangible way, establishing the relationships between the elements that make up furniture on a human scale.

Through this exercise, the aim for the student is to acquire a general knowledge of the most important aspects when designing or producing this kind of home furniture.

What methodology can be used for its integration into the classroom/curriculum?
It is totally applicable in training methodologies based on gamification, and it has a special application through a project-based methodology, using, in this case, a design problem for the furniture elements on which the application provides information. Students would use the application to investigate what relationships or considerations need to be considered to obtain a suitable design.

What benefits can be obtained with its use?
It allows access to realities that may be inaccessible in many cases in the absence of Virtual Reality, either due to the physical impossibility of having that reality, due to economic cost or distance. The students will interact in a total immersion environment with the two pieces of furniture, in a quasi-tangible way and on a human scale, very similar to as if they were really interacting with physical objects, thus helping to fix their attention.

The acquisition of information is done through a gamified process, closely related to recreational activities, which further reinforces the attention and concentration of the student. The information is shown through the interaction with elements located in specific areas of the furniture, causing a relationship to be generated between the information provided and the place on which it is reported, helping the student to establish these relationships.

GRAPHIC DESCRIPTION

Figure 46: Make tips Exercise 3.

EXERCISE 4: HOSPITAL FURNITURE – GERIATRIC BED. DESCRIPTION.

Recommended dimensions:

- Back section length: 74 – 84 cm.
- Seat section length: 18.5 – 21 cm.
- Upper leg section length: 37 – 42 cm.
- Lower leg section length: 55.5 -63 cm.
- Angle between back & seat: > 90°
- Angle between seat & upper leg: 0°. >12°

- Angle between upper & lower leg: 180º
- Total length: 185 – 210 cm.
- Total width: 80 – 120 cm.
- Total height(adjustable): 40 – 90 cm.
- Handrails height: > 22 cm.
- Handrails width: > 50% of mattress length
- Headboard height: 25 – 50 cm.
- Headboard width: 60 – 80 cm.
- Footboard height: 24 -40 cm.
- Footboard width: 60 – 80 cm.
- Diameter gaps between bars: < 12 cm.
- Spacing between moving parts: < 0.8 or > 2.5 cm.

Design advice:

- Gaps in these areas must be less than 120 mm to avoid entrapments. 120 mm it's the percentile 5º for width of a female head.
- Gaps between the Headboard and adjacent Side Rail must be less than 60 mm to avoid entrapments. 60 mm it's the percentile 5º for width of a female neck.
- Gaps between the Footboard and adjacent Side Rail must be less than 60 mm or more than 318 mm. This last dimension, it's the width of the percentile 95º for an adult man chest.
- For protect against inadvertent falls the height for side rails from the mattress must be 220 mm or more. This dimension is the middle value of the percentile 95º for an adult man's back.
- Bed must be designed for holding the mattress in its position during a normal use and for avoiding its movement.
- Foot and toe clearance are between moving parts at the floor. The dimensions are only measured from the outer edge of the medical bed or from the floor. The outer edge includes any permanently fixed accessories.
- The angle that is show in the picture, between the back section and leg-upper section must be always greater than 90º under normal conditions.

Techniques and materials:

- The equipment must be correctly labelled in accordance with the instructions for medical devices. Information must include:
- Identification of manufacturer and bed model. Maximum patient weight and safe working load.
- Cleaning instructions: whether automatic washing system or pressure jet system are possible.
- Adjustment in width.
- Compatible type of mattress.
- Warning of replacing the removable side rails (if any) with incompatible rails.
- Controls and-or indicators, when possible, shall be marked using symbols that convey the intended function of those controls or indicators without the need for additional text.
- The bed must include a user manual where the operators or responsible team will be instructed on how to conduct preventive inspection, maintenance and-or calibration.
- To optimise the performance of the bed, maximise its lifetime and achieve smooth, soft, and progressive movements, it is essential to ensure good joints in the whole set of joints in the hospital bed. Using bushes, washers and bearings will help to achieve it.
- Actuators are another critical component of a hospital bed, and their quality must be assured in terms of speed, force, travel and levels of protection and insulation against external elements, such as water and dust.
- Nowadays, most beds used in hospital environments are designed to carry patients. For this purpose, casters are a key component to be considered when manufacturing hospital beds. To choose the right supplier, casters should swivel correctly, overcome certain obstacles, and offer ease of movement and quiet operation.

Content evaluation:

- Which of the following dimensional ranges would be correct to define the height of the existing holes in the perimeter railings? <6 cm, <12 cm, >12 cm.
- Indicate whether the following statement is correct or not: The height of the railing measured from the top of the mattress must always be less than 220 cm.

- Of the following characteristics of the medical bed: Which should always be indicated?
- The maximum weight of the patient.
- The minimum weight of the patient.
- The type of compatible mattress.
- The maximum weight of the mattress.
- Identification of the model and manufacturer.
- Diameter of the wheels.

Indicate if the following statement is true: The length of the backrest must be between 74 cm and 84 cm.

PRESENTATION OF THE EXPERIENCE

It is about an immersive Virtual Reality experience where the student interacts in a completely virtual environment with a hospital bed. The student discovers information as he/she interacts with the elements of the scene through system controls. The information is shown to the student through the HMD.

TEACHING SPECIFICATION

What is the experience intended to teach the student? Description of the learning scenario.
The student will find himself in front of a hospital bed, and through the interaction with this element, he/she will discover information and advice about ergonomics, manufacturing, dimensions, finishings, etc.
At all times the student is related to the furniture elements in real scale, where not only abstract information of magnitudes and data is shown, but it can be observed it in a much more tangible way, establishing the relationships between the elements that make up furniture on a human scale.
Through this exercise, the aim for the student is to acquire a general knowledge of the most important aspects when designing or producing this kind of home furniture.

What methodology can be used for its integration into the classroom/curriculum?

It is totally applicable in training methodologies based on gamification, and it has a special application through a project-based methodology, using, in this case, a design problem for the furniture elements on which the application provides information. Students would use the application to investigate what relationships or considerations need to be considered to obtain a suitable design.

What benefits can be obtained with its use?

It allows access to realities that may be inaccessible in many cases in the absence of Virtual Reality, either due to the physical impossibility of having that reality, due to economic cost or distance.

The students will interact in a total immersion environment with the two pieces of furniture, in a quasi-tangible way and on a human scale, very similar to as if they were really interacting with physical objects, thus helping to fix their attention.

The acquisition of information is done through a gamified process, closely related to recreational activities, which further reinforces the attention and concentration of the student. The information is shown through the interaction with elements located in specific areas of the furniture, causing a relationship to be generated between the information provided and the place on which it is reported, helping the student to establish these relationships.

GRAPHIC DESCRIPTION

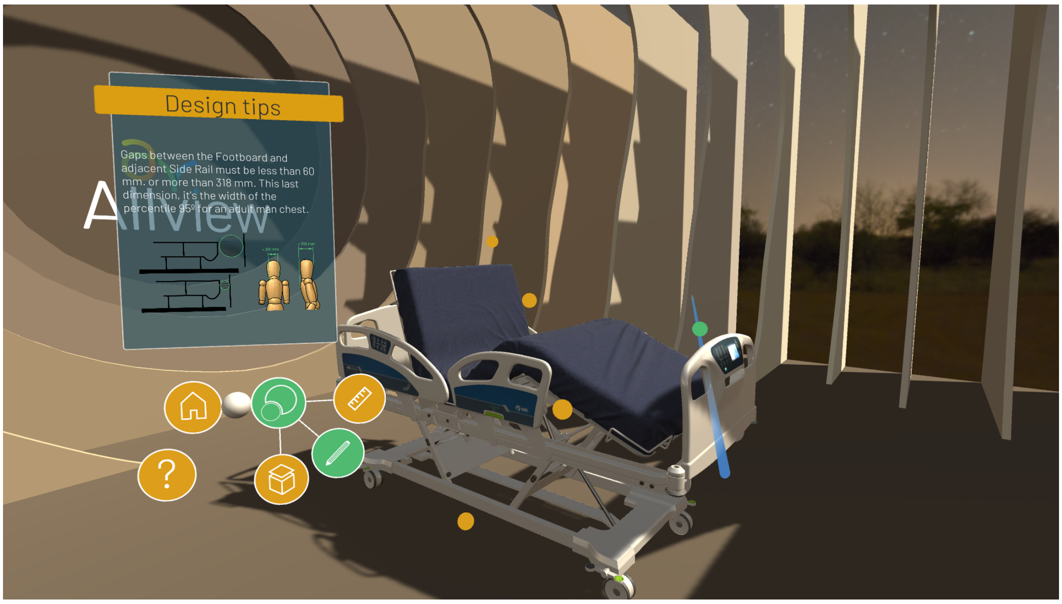


Figure 47: Design tips Exercise 4.

360 VR videos. Immersive experience involving 2 exercises

INFORMATION

Exercise Name	Places that have a training interest in the wood and furniture sector.
Specific Subject	Furniture design, rapid manufacturing, and validation for finished products.
Theme (Short explanation of its use)	This experience consists of 2 exercises through which the student will acquire knowledge about design techniques, design methodologies, prototyping, rapid manufacturing, and validation techniques for finished products.

EXERCISE 1: CETEM FABLAB TOUR

Places:

- CETEM main entrance.
- Hall reception.
- CETEM design awards exhibition.
- Product engineering department.
- Prototypes workshop.
- Pre-series and finishing area.
- Robot area.
- Additive manufacturing area.

Content Summary:

- What is a technological center and what is its mission.
- How a technological center is organized. Technological areas.
- Design methodologies. The three major phases of the design process at CETEM.
- Advanced design tools, contactless digitizer and reverse engineering, and development of simulations and interactive applications.
- Examples of innovative projects: Development of an innovative mattress core, a door frame with a ventilation system, and a nebulized hydro alcohol dispensing device.
- Short series and finishings. Rotational molding techniques, vacuum casting, RIM low pressure injection, surface finishings.
- Large volume prototypes using a robotic arm. Indirect and direct tooling applications.
- Prototyping techniques, FFF systems, SLA systems, and SLS systems. Systems for recycling plastics and to produce new 3D printing filaments.

Content evaluation:

- Which of the following statements does not correspond to one of the major phases for product development in the design process carried out by CETEM?

  Technical development of the idea.

  Equipment calibration.

  Prototype production.

  Design validation.

- Which of these characteristics corresponds to the parts of the prototypes made using the cold rotomolding technique?

  The pieces produced are completely closed and hollow inside.

  Parts are made from powdered plastic material.

  The parts obtained cannot have metal inserts.

- With how many axes does the large machining robotic cell work?

  2 axes.
  3 or 5 axes.
  7 axes.

- What are the systems that work by extruding a plastic filament through a nozzle called?

  FFF or FDM
  SLA
  SLS

PRESENTATION OF THE EXPERIENCE

It is an experience that can be enjoyed immersively if you have VR equipment, or it can be also experienced normally through a monitor or simple screen. Once the mode is selected, the student takes an interactive tour through the different areas that make up the FabLab of the CETEM design department, the different areas are represented by means of 360 photographs and interactive zones where information related to the area will be specifically provided.

TEACHING SPECIFICATION

What is the experience intended to teach the student? Description of the learning scenario.

The students will go through the space where the experience takes place, visualizing it through high-resolution real images with a spherical envelope, where they will be able to observe any detail in any direction, the experience provided is like what they can perceive by being right in that place. In addition, the different panoramic scenes are fed by various multimedia elements that enrich the experience by providing the student with knowledge and information about each of the areas or processes shown.

From this exercise it is intended that the student acquires general knowledge about systems for the manufacture of prototypes and design methodologies.

What methodology can be used for its integration into the classroom/curriculum?

It can be fully applied in training methodologies based on gamification, and it also has a special application through a project-based methodology, being able to consider in this case the choice of a certain rapid manufacturing technology to produce the prototype of a previously elaborated design. Students would use the application to research and determine which prototyping technology is best suited to the designed product or intended use of the prototype.

What benefits can be obtained with its use?

It allows access to realities that in many cases may be inaccessible either due to distance or availability. In addition, the experiences are available at any time and are accessible not only through VR equipment, but also through any device that can access internet and have a web browser you can enjoy the experience.

Students relate to space through an exact copy of its reality, being able to observe any type of detail with total fidelity.

The acquisition of information is done through a gamified process, closely related to recreational activities, which further reinforces the attention and concentration of the student. The information is shown through the interaction with elements located on the zones or components to which it refers. This creates a relationship between the information and the element, technique, object, etc., that its being shown. This information can be multimedia, allowing the incorporation of videos, audio, music, text, images and even 3D elements, which gives incredible versatility when it comes to displaying the content and getting the information to the student.

GRAPHIC DESCRIPTION

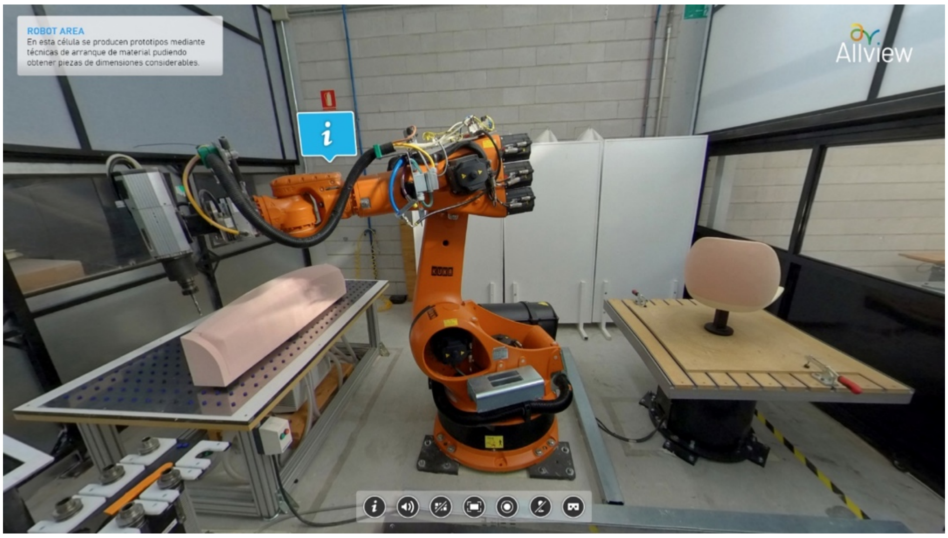


Figure 48: Robot area.

Figure 49: Additive Manufacturing area.

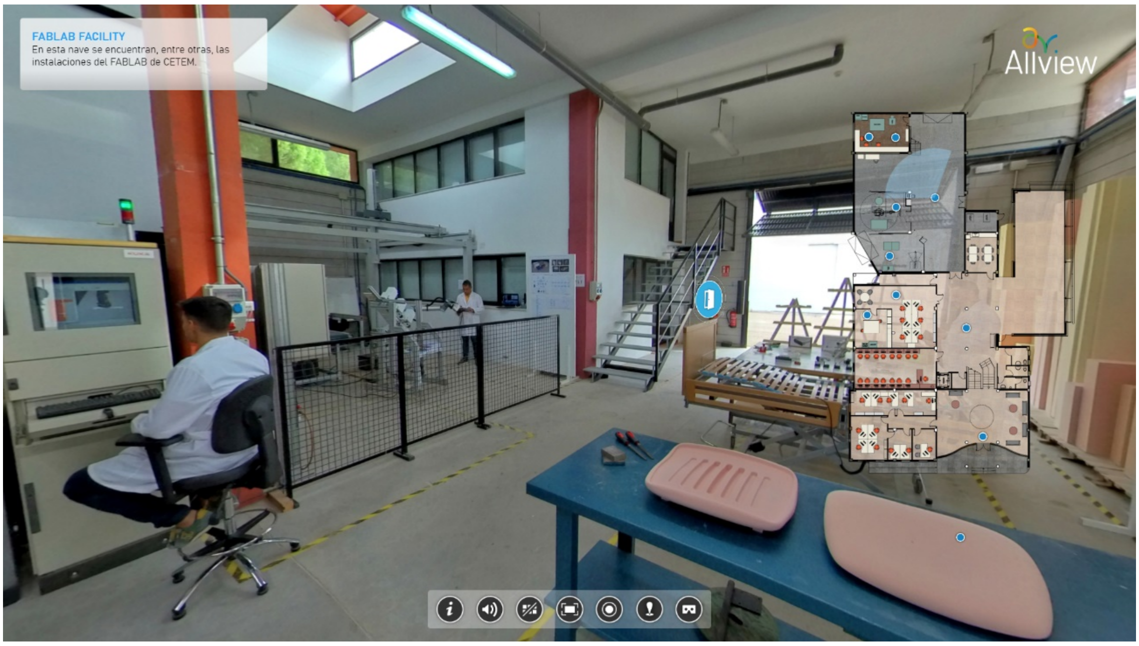


Figure 50: FabLab Facility.

Figure 51: Preparation and Finishing area.

EXERCISE 2: CETEM FURNITURE TESTING LAB TOUR.

Places:

- CETEM main entrance.
- Hall reception.
- Innovation Factory
- Finish Product Testing Lab Area
- Finish Product Testing Lab 1
- Finish Product Testing Lab 2
- Finish Product Testing Lab 3
- Finish Product Testing Lab 4
- Mechanism testing area for large samples.

Content Summary:

- What is a technological center and what is its mission.
- How a technological center is organized. Technological areas.
- General information about a furniture testing laboratory.
- What is an accredited laboratory.
- CE Marking
- Available tests and European and national standards for furniture.
- Strength and durability testing machines for small and big furniture, such as chairs and sofas, or tables.
- Testing of mechanisms for seating and sofa-beds, office chairs, mattresses, coffins, medical beds, etc.
- Impact tests.
- Stability/Overbalancing.
- Using robots for testing furniture like medical beds.

Content evaluation:

- What means the CE marking in a product?
- Fulfilling all the EU requirements for the product.
- That a third party has evaluated the product, in terms of safety.
- That the product can be sold in EU.
- What is the difference between an accredited laboratory and a non-accredited laboratory?
- A non-accredited laboratory cannot perform test.
- An accredited laboratory has been evaluated by a national accreditation organism.
- Both can perform all kind of tests, but the non-accredited laboratory cannot issue test reports.
- Robots are mainly used (in a furniture testing laboratory) for…
- Performing mainly stability tests.
- All kind of tests but testing chairs mainly.
- Performing long-term and repetitive tests, such as durability.
- Durability/fatigue tests are intended to…
- Prove that furniture can last for many years, with a reasonable use.
- Prove the safety and strength of a piece of furniture.
- Demonstrate that furniture can withstand heavy loads.

PRESENTATION OF THE EXPERIENCE

It is an experience that can be enjoyed immersively if you have VR equipment, or it can be also experienced normally through a monitor or simple screen. Once the mode is selected, the student takes an interactive tour through the different areas or spaces that make up the furniture testing laboratory of CETEM. The different areas are represented by means of 360 photographs and interactive zones where information related to the area will be specifically provided.

TEACHING SPECIFICATION

What is the experience intended to teach the student? Description of the learning scenario.

The students will go through the space where the experience takes place, visualizing it through high-resolution real images with a spherical envelope, where they will be able to observe any detail in any direction, the experience provided is like what they can perceive by being right in that place. In addition, the different panoramic scenes are fed by various multimedia elements that enrich the experience by providing the student with knowledge and information about each of the areas or processes shown.

From this exercise it is intended that the student acquires general knowledge about how a testing laboratory for diverse furniture works. He/she will learn about tests for furniture such as stability tests, durability tests, overbalancing tests, impact tests, how to use robots for long-term tests, etc.

What methodology can be used for its integration into the classroom/curriculum?

It can be fully applied in training methodologies based on gamification, and it also has a special application through a project-based methodology, being able to watch in this case the different kind of mechanical tests for furniture. Students would use the application to research about different tests available in European standards for evaluating the strength, durability, stability in different type of furniture.

What benefits can be obtained with its use?

It allows access to realities that in many cases may be inaccessible either due to distance or availability. In addition, the experiences are available at any time and are accessible not only through VR equipment, but also through any device that can access internet and have a web browser you can enjoy the experience. Students relate to space through an exact copy of its reality, being able to observe any type of detail with total fidelity. The acquisition of information is done through a gamified process, closely related to recreational activities, which further reinforces the attention and concentration of the student. The information is shown through the interaction with elements located on the zones or components to which it refers. This creates a relationship between the information and the element, technique, object, etc., that its being shown. This information can be multimedia, allowing the incorporation of videos, audio, music, text, images and even 3D elements, which gives incredible versatility when it comes to displaying the content and getting the information to the student.

GRAPHIC DESCRIPTION

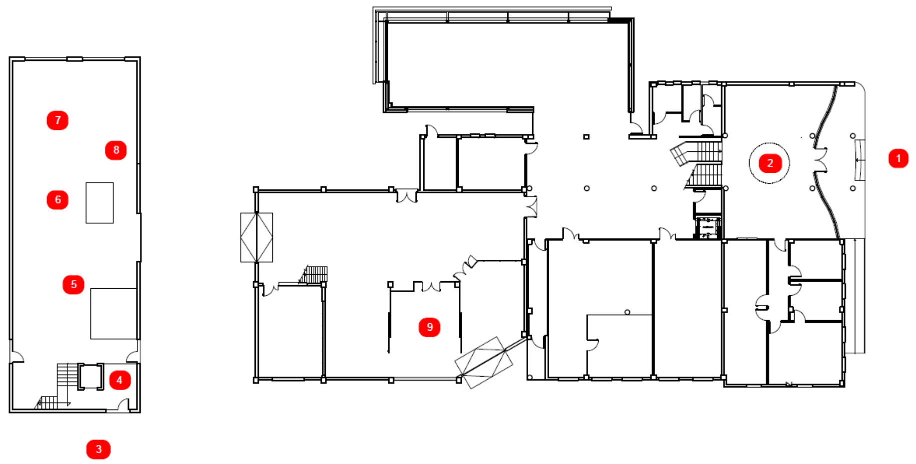


Figure 52: Tour Plan.

Figure 53: Seat test contents.

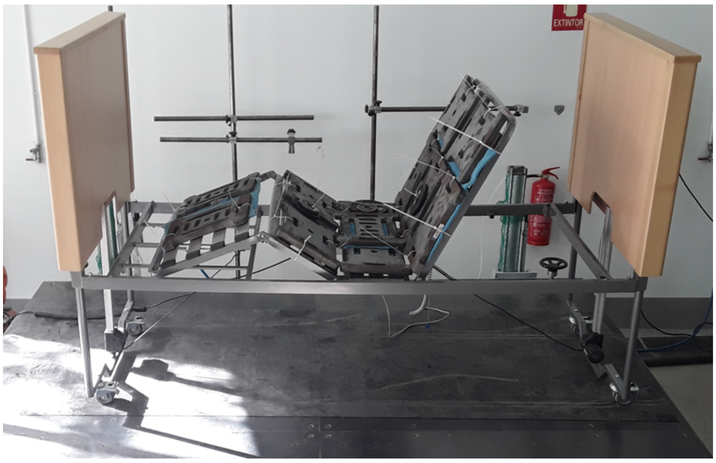


Figure 54: Geriatric Bed.

Definition of Virtual Reality exercises with SimLab.

EXERCISE 1: OPERATE A TABLE CIRCURAL SAWING MACHINE FOR SAWING A LAMINATED CHIPBOARD IN VR.

INFORMATION

Exercise Name	Operate a table circular sawing machine for sawing a laminated chipboard in VR
Specific Subject	VR
Theme (Short explanation of its use)	Within the VR area there is an Altendorf table circular sawing machine. Users undergo the steps to be taken to saw a laminated chipboard into small pieces.

PRESENTATION OF THE EXPERIENCE

In VR, the student will stand in front of an Altendorf table circular sawing machine, the most widely used saw table in Europe, and will have to perform all the necessary steps to saw a laminated chipboard into smaller pieces.

They will have to practise the right order of steps and be aware of safety. The students will be able to do all this with the VR controllers in their hands. With these controllers' students can touch buttons or grab objects in de VR environment. On a large screen in front of the student, the steps to be taken at that moment are projected.

Figure 55: View through virtual reality goggles. Steps to cut a laminated chipboard.

Step's to be taken:

- Put the sawblade in the right position by pressing the "+" button on the control panel.
- Put the rip fence in the right position to saw strips of 100 mm width.
- Grab the laminated chipboard from the disposal area to your left and place it on the saw table.

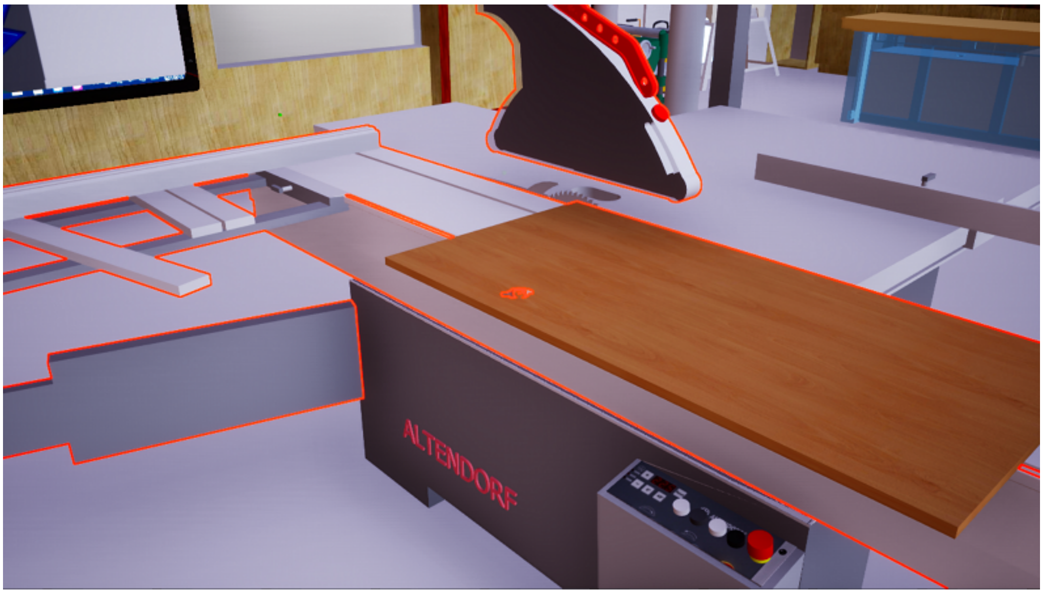


Figure 56: View through virtual reality goggles. Laminated chipboard place on the saw table.

- Move the top safety hood down.
- Move the laminated chipboard forward so it touches the fence.
- Move the saw table backwards to saw position.
- Move the laminated chipboard 5mm past the saw blade to saw the board clean.
- Turn on the saw and the scoring saw blade.
- Move the table forward and saw the board clean.
- Move the table backwards to saw position.
- Move the laminated chipboard against the rip fence to saw a strip of 100mm.
- Move the table forward again to saw the strip.
- Move away the sawn-off strip.
- Move the table backwards again.
- Repeat steps 11 to 14 three times.
- Grab the push stick from the safety hood and push the laminated chipboard forward to saw the last strip.
- Turn off the saw and scorer saw.

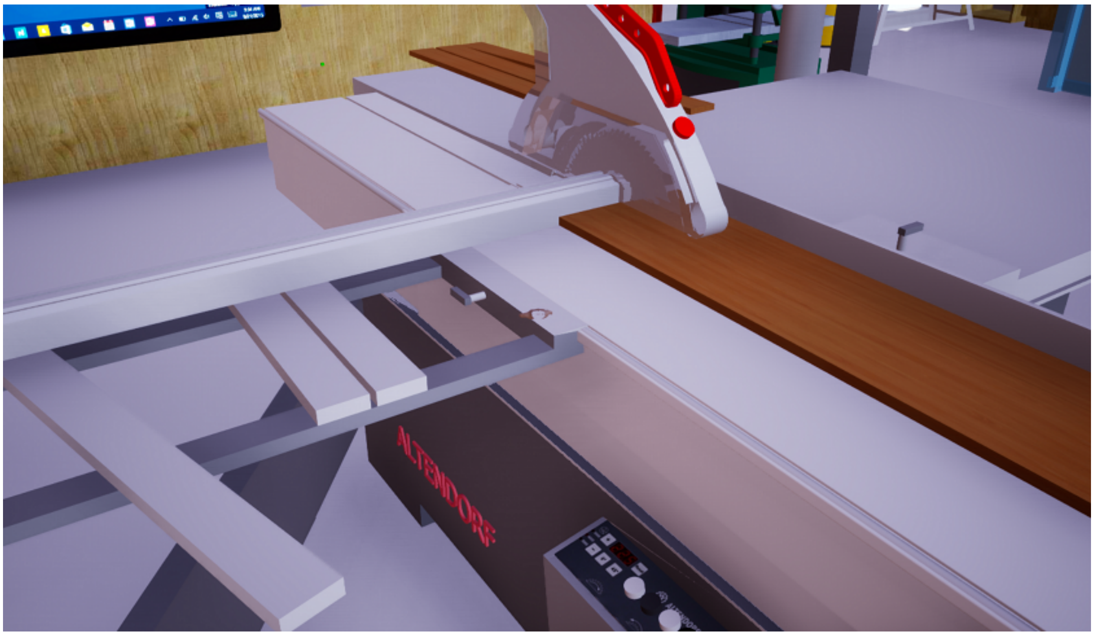


Figure 57: View through virtual reality goggles. Laminated chipboard being sawn.

EXERCISE 2: OPERATE A TABLE CIRCURAL SAWING MACHINE FOR SAWING MASSIVE WOOD IN VR

INFORMATION

Exercise Name	Operate a table circular sawing machine for sawing massive wood in VR
Specific Subject	VR
Theme (Short explanation of its use)	Within the VR area there is an Altendorf table circular sawing machine. Users undergo the steps to be taken to saw a massive wooden beam into small pieces

PRESENTATION OF THE EXPERIENCE

In VR, the student will stand in front of an Altendorf table circular sawing machine panel saw, the most widely used table circular sawing machine in Europe and will have to perform all the necessary steps to saw a massive wooden beam into four square beams, then the beams must be shortened on both sides.

They will have to practise the right order of steps and be aware of safety. The students will be able to do all this with the VR controllers in their hands. With these controllers' students can touch buttons or grab objects in the VR environment. On a large screen in front of the student, the steps to be taken at that moment are projected. The steps to be taken are being told in audio as well.

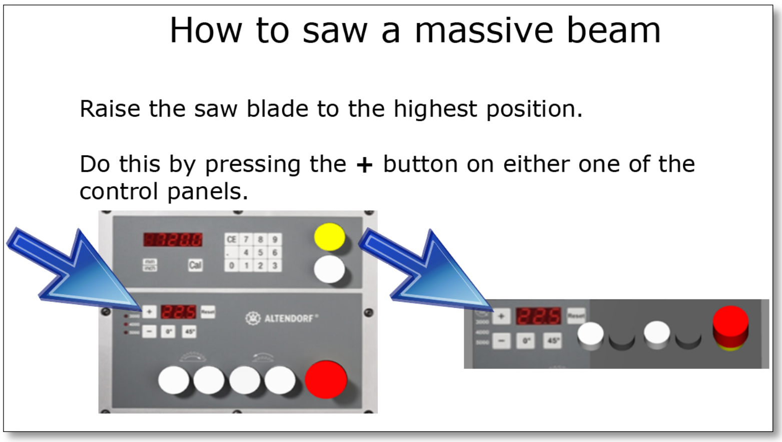


Figure 58: View through virtual reality goggles. Instructions on the screen.

Step's to be taken:

- Put the sawblade in the highest position by pressing the "+" button on the control panel.
- Put the rip fence in the right position to saw beams at 54 mm width.
- Put the rip fence forward so the front is 2 cm further than the point where the beam is cut.
- Move the saw table forward until the end and lock the table.
- Grab the massive beam from the cabinet to your left and place it on the saw table.

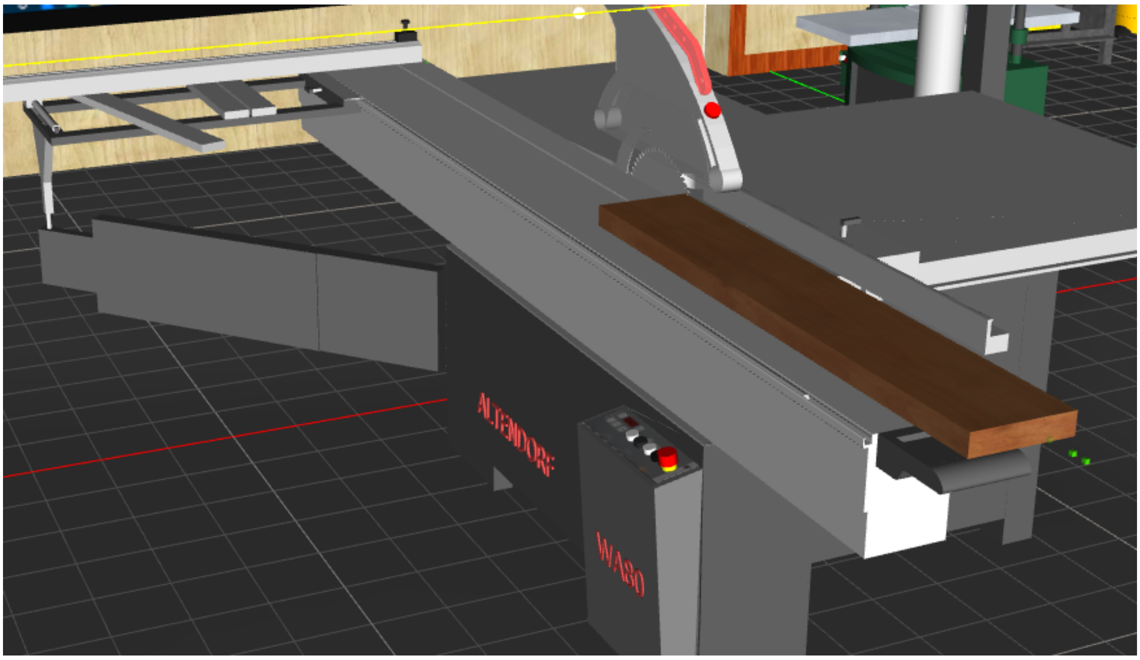


Figure 59: View through virtual reality goggles. Massive beam placed on the saw table.

- Move the top safety hood down.
- Move the massive beam against the rip fence to saw a strip of 54mm.
- Turn on the saw.
- Move the massive beam forward and saw the beam, push the last part with the push stick.
- Grab the sawn-off beam and put it on the cabinet.
- Grab the massive beam and put it in sawing position.
- Repeat steps 9 to 11 three times.
- Unlock the sliding table and move it backwards so the crosscut fence is before the saw.
- Grab one sawn-off beam and put the length of it against the crosscut fence.

- Move the sawn-off beam around 5 mm past the saw blade to saw the head of the beam clean.
- Move the table forward and saw the beam's head clean.
- Move the beam to the disposal area.
- Move the table backwards to saw position.
- Repeat steps 14 to 18 three times.
- Move the rip fence about 500 mm away from the saw.
- Set the crosscut fence stop to 1200 mm.
- Grab one beam from the cabinet and put it on the crosscut fence against the clamp.

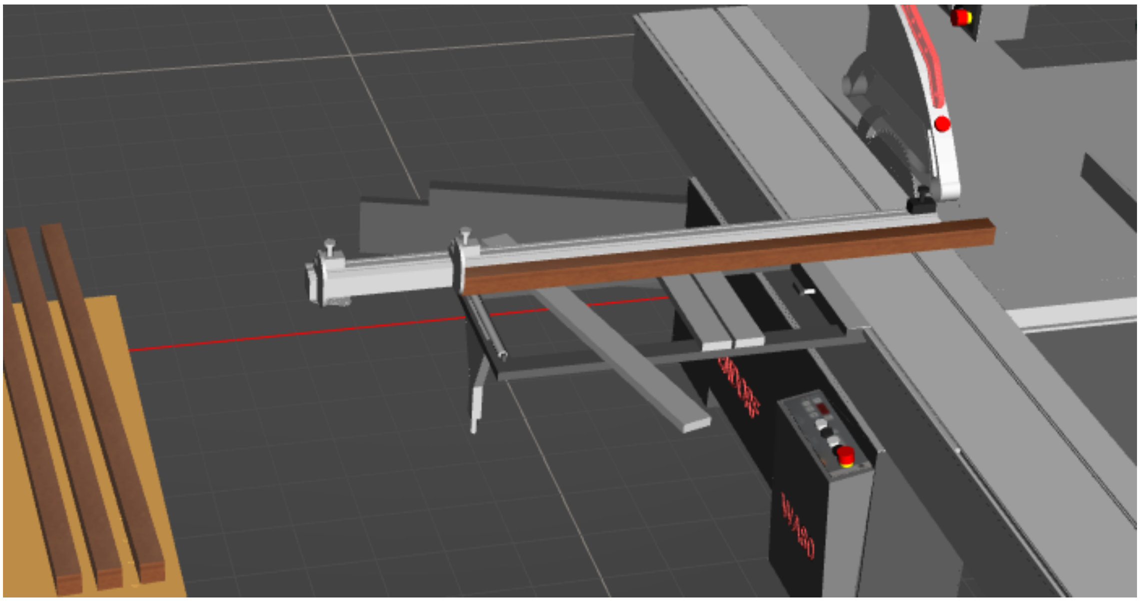


Figure 60: View through VR goggles. Sawn-off beam placed on the saw table against the crosscut fence stop.

- Move the table forward to saw the beam at 1200 mm length.
- Grab the beam and put it on the disposal area.
- Move the table backwards to saw position.
- Repeat steps 22 to 25 three times.
- Turn off the saw.

TEACHING SPECIFICATION FOR BOTH EXERCISES.

What is the experience intended to teach the student? Description of the learning scenario.
Students learn how to operate this machine in a safe way before they start working on the real machine. They can practise as many times as they want to.

What methodology can be used for its integration into the classroom/curriculum?
There might be just one or two real panel saw tables in the school, there are lots of students. So, to practise these steps on the real machine they must wait in line. This exercise can help them to practise all the steps in VR. If they, for instance, practised 5 times, they are qualified to get to work on the real machine.
This exercise is fully applicable in training methodologies based on gamification and has special application through a project-based methodology, confronting them in this case, with the learning of dangerous machinery before facing the real project. The students would use virtual reality to learn and internalise the use and operation of the cutting machine.

What benefits can be obtained with its use?
They can practise far more to learn how to operate the machine, so they will learn in better. They learn operating the saw table in a safe way.
In this way, the group learning process is accelerated, since, during the waiting times before using the real machine, the trainee will be able to learn how it works and be more prepared in terms of knowledge about the use and safety of the machine before facing the real work.

TECHNICAL SPECIFICATION OF BOTH EXERCISE

Software being used to create the exercise:

- *SimLab VR Studio 10*
- *SimLab Cloud Sharing* (only when wireless VR headsets are being used)

Hardware being used:

- Any VR device. Pico Neo, Oculus Quest, HTC Vive, etc.
- Windows 10 computer with powerful graphic card like NVIDIA GeForce RTX 2070 or

- AMD Radeon RX 5700 XT (only when a wired VR headset is used)

Figure 61: Pico Neo 3 wireless headset with controllers.

Figure 62: Meta Quest 2 wireless headset with controllers.

Figure 63: HTC Vive Pro wired headset with controllers and tracking devices.

Figure 65: NVIDIA GeForce RTX 2070.

Figure 64: AMD Radeon RX 5700 X.

Definition of Mixed Reality exercises – Microsoft Dynamics 365 Guides

EXERCISE 1: ASSEMBLING A HALL CABINET

INFORMATION

Exercise Name	Assembling a hall cabinet.
Specific Subject	Getting to know the different wood compounds.
Theme (Short explanation of its use)	The exercise consists of assembling a corridor cabinet with guided instructions using Mixed Reality. With this exercise the students get to know new connections, their properties and how to work with MR. This exercise is planned for the students to design their own connections and the final model, with the intention to manufacture and assemble the furniture as a final task with the help of MR.

PRESENTATION OF THE EXPERIENCE

Figure 66: Student at the exercise.

Figure 67: General view of the panels.

Figure 68: Student with a HoloLens.

The learner not only learns new connection techniques, but also works with new technologies. AR will be increasingly present in the workplace in the coming years, and it is important that students adapt and be prepared to work with these technologies. This will give them a competitive edge for the new jobs demanded by companies.

Through the HoloLens glasses an extra layer over the real world can be visualised. Through this technology, with the appropriate hardware and software, the student is guided step by step through the assembly process. Both textually and with a video. Thanks to the holograms, they cannot make any mistakes in the assembly process.

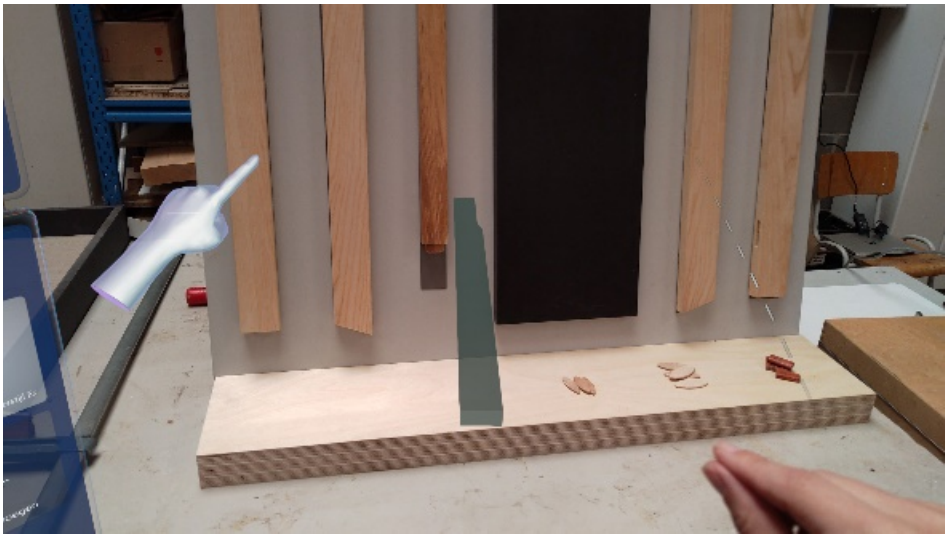


Figure 69: View from the HoloLens at the holograms.

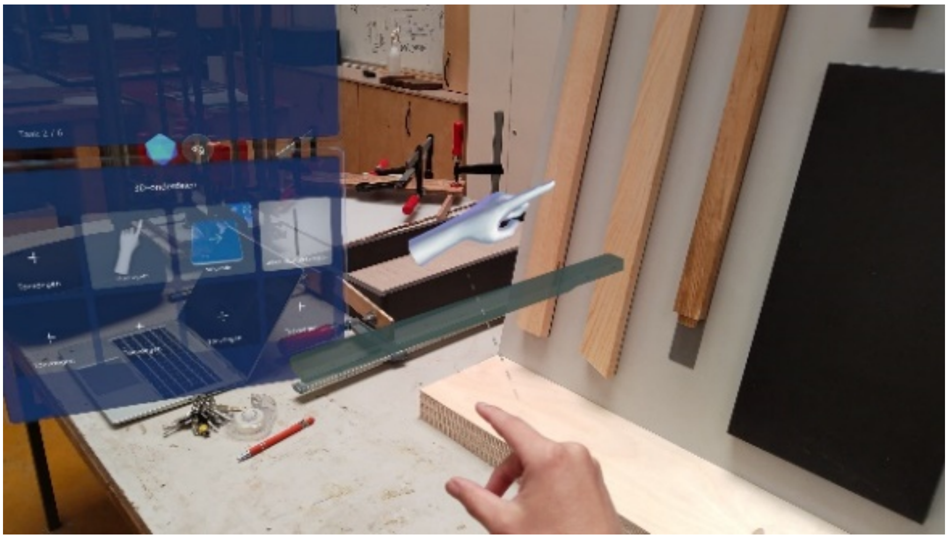


Figure 70: View from the HoloLens placing the holograms.

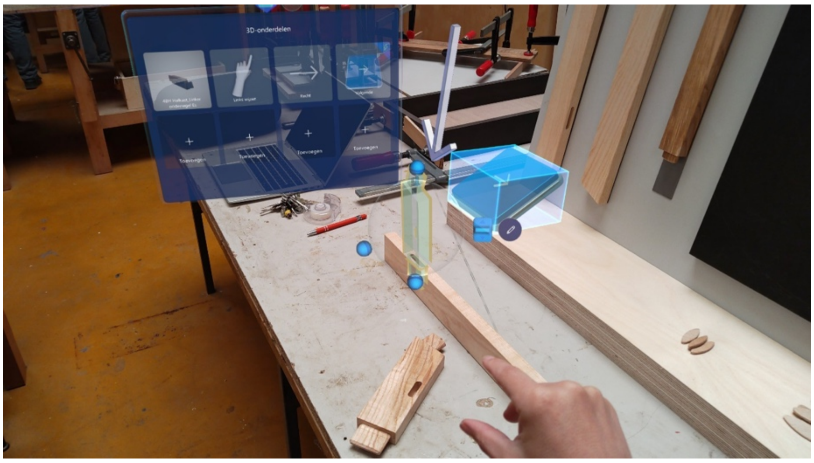


Figure 71: Modifying the holograms.

TEACHING SPECIFICATION

What is the experience intended to teach the student? Description of the learning scenario.

Each student will perform this guided assembly task with mixed reality one by one. While other students start to design their own models. This will give them a better understanding of the structure of the furniture, materials, and possible connections.

In the case of students who are late to start school, this type of exercise and technology helps them to catch up more quickly and acquire the necessary knowledge and skills.

What methodology can be used for its integration into the classroom/curriculum?

This exercise is part of the hall cabinet project, which is developed in the following steps:

- Freehand sketch of the design.
- 3D design of the parts and complete furniture.
- Manufacture of the pieces in the workshop.
- Guided assembly with Mixed Reality.

This is a simple exercise to introduce students to technology and how to work with it, obtaining all the benefits it provides both cognitively and in terms of creativity and innovation.

During the course, several projects will be developed and the difficulty of them will increase to broaden knowledge. The teacher can write a guide to work with HoloLens in each of the projects to be developed during the school year.

EXERCISE 2: HOLOLENS INSTRUCTIONS FOR WORKING WITH CNC MACHINES.

INFORMATION

Exercise Name	HoloSupport
Specific Subject	HoloLens instructions for working with CNC machines.
Theme (Short explanation of its use)	Through an extra virtual layer with the HoloLens, the students and teachers receive instructions to perform certain actions on a CNC machine.

PRESENTATION OF THE EXPERIENCE

Figure 72: With HoloLens at the CNC machine.

The student/ teacher cannot always count on help to work on a CNC machine. To avoid experimenting with the machine, we offer a tool based on the HoloLens. With the HoloLens you can choose which action you want to perform on the machine and for what you get help.

Possible split: new program upload, tool change, error message troubleshooting; machine shutdown, machine startup.

Before a procedure can be chosen, the safety instructions must always be followed.

The HoloLens then takes you step by step through the action. With holograms, explanation cards and short instruction videos on the HoloLens you get the right instructions. The HoloLens is Augmented Reality, an extra layer on reality. So, one can immediately start carrying out the instructions and help received on the machine. No remotes are used, your hands are the remotes and are being tracked by the HoloLens.

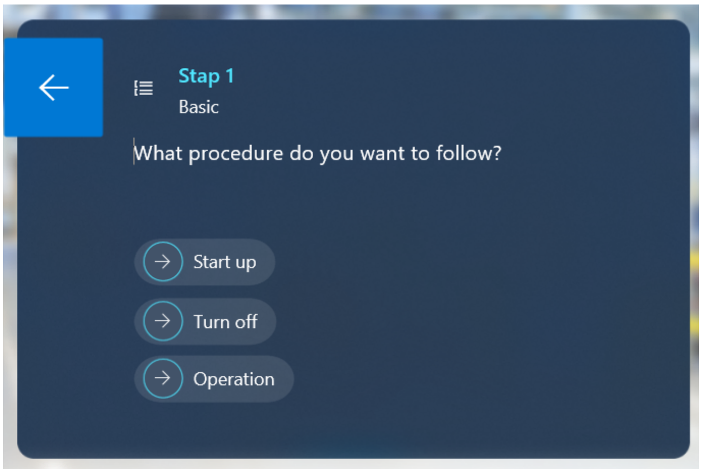


Figure 73: Question step in the guide.

When building up the instructions, it is also possible to use 3D parts of the machine. Building the instructions is done threw a program on the computer, such as building a PowerPoint presentation.

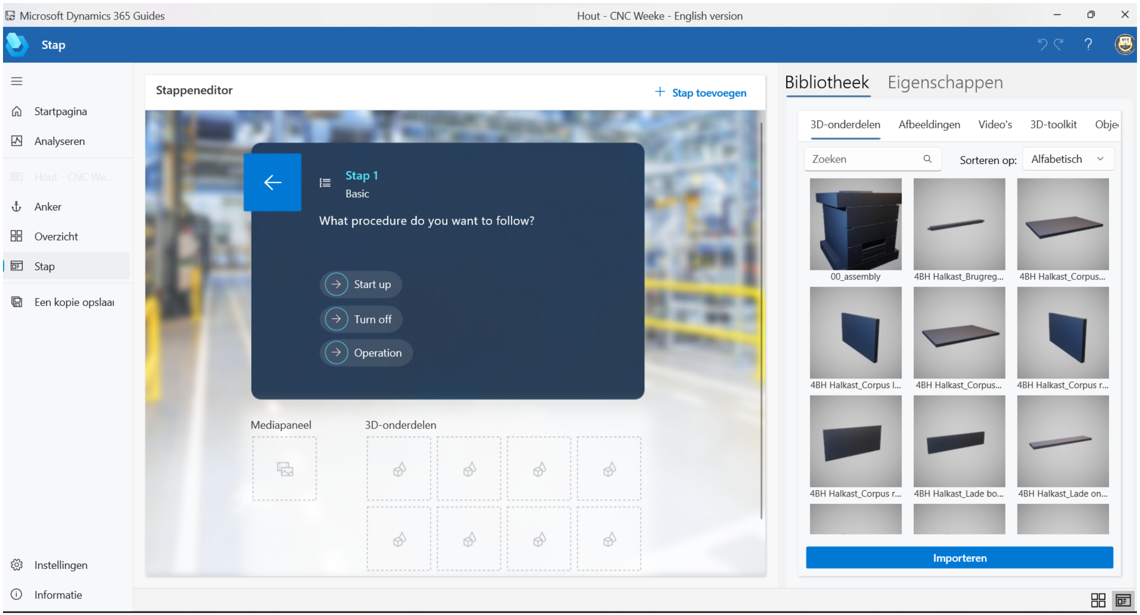


Figure 74: View from the guides program at the PC.

TEACHING SPECIFICATION

What is the experience intended to teach the student? Description of the learning scenario.

In the first instance, the student learns to work with new technologies, which will become increasingly important in their future workplace. Additionally, the student gains the ability to operate a new CNC machine proficiently and safely without constant guidance from a teacher.

Figure 75: Working with the HoloLens at the machine.

What methodology can be used for its integration into the classroom/curriculum?

There will be a HoloLens present in every workshop. When the student wants help working with a certain machine, the student will be able to take the HoloLens and scan the QR code on the machine. This will immediately start the correct instructions manual.

What benefits can be obtained with its use?

What are the benefits of using this machine? Students can safely familiarize themselves with its operation, gradually working through each step at their own pace. If needed, they can receive assistance for any difficult steps. Furthermore, they have the flexibility to choose which steps to work on independently, and then progress to the next stage with greater confidence and proficiency.

7

Conclusions

7. Conclusions

Digital technologies have become a powerful tool for improving education in various ways, such as facilitating the creation of instructional materials and enabling new methods of learning and collaboration. By integrating digital technologies into the educational process, new perspectives are opened to improve the effectiveness of training and increase the motivation of learners. These technologies can also help develop students' digital competences, preparing them for the demands of future jobs.

The integration of Extended Reality (XR) technologies in furniture and woodworking education can provide students with a range of skills. Some of the most salient competencies that can be draw from this report include:

Technical skills: the use of XR technologies in furniture and woodworking education can help students acquire technical skills in furniture making and wood construction. Practice with virtual tools and equipment can help students better understand manufacturing processes and improve their technical skills.

Design skills: XR technologies can be used to create virtual designs and prototypes of furniture and wood constructions. This allows students to experiment with different designs and materials and improve their ability to visualise and create designs effectively, helping students to develop skills in spatial visualisation, enabling them to see objects and designs in 3D and explore different perspectives and angles.

Teamwork skills: XR technologies can be used to foster collaboration between students, allowing them to work together on design and construction projects. Virtual collaboration can help students develop communication and teamwork skills.

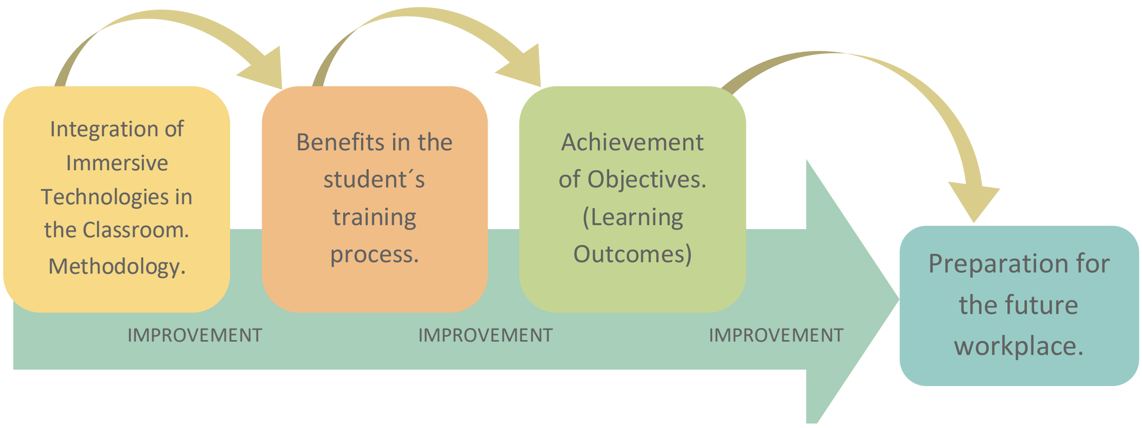
Problem-solving skills: Using XR technologies in furniture and woodworking education can help students develop problem-solving skills. Students can experiment with different designs and materials virtually, allowing them to identify and solve problems before starting actual production. In addition, it can provide students with a platform to experiment and solve complex problems related to the design and construction of wooden furniture and objects.

Innovation skills: XR technologies can be used to foster creativity and innovation in the design and production of furniture and wooden constructions. Students can experiment with different ideas and designs virtually, allowing them to explore new solutions, innovative approaches, and design concepts in a boundless virtual environment.

The integration of extended reality (XR) technologies in furniture and wood education offers numerous advantages. Students can experiment with different designs and materials in a more immersive and realistic way, allowing them to develop skills and competencies in a more practical and engaging environment. The use of these technologies can also improve teaching efficiency by allowing teachers to reach a larger number of students more efficiently. Furthermore, the integration of XR in furniture and wood education can help drive innovation and creativity in the design of sustainable and energy-efficient furniture and materials. Overall, the use of XR technologies in education is a growing trend that is transforming the way teaching and learning takes place in the furniture and wood sector, offering new opportunities and improving the quality of education.

As part of the digital transformation of education, the use of digital technologies in the educational process opens wide prospects for improving the efficiency of the training process. The integration of these technologies in educational institutions will increase modern pedagogical trends that will help to increase the motivation of learners. Moreover, it will enhance the development of their digital competences. All the benefits discussed in chapter three have a large impact on the use of the mentioned technologies and will significantly enrich the training process of students, preparing them for the demands of future jobs.

This report provides a holistic view of extended technologies, examining their use and benefits in education, the skills they can develop, and their applications in the furniture and wood sector.

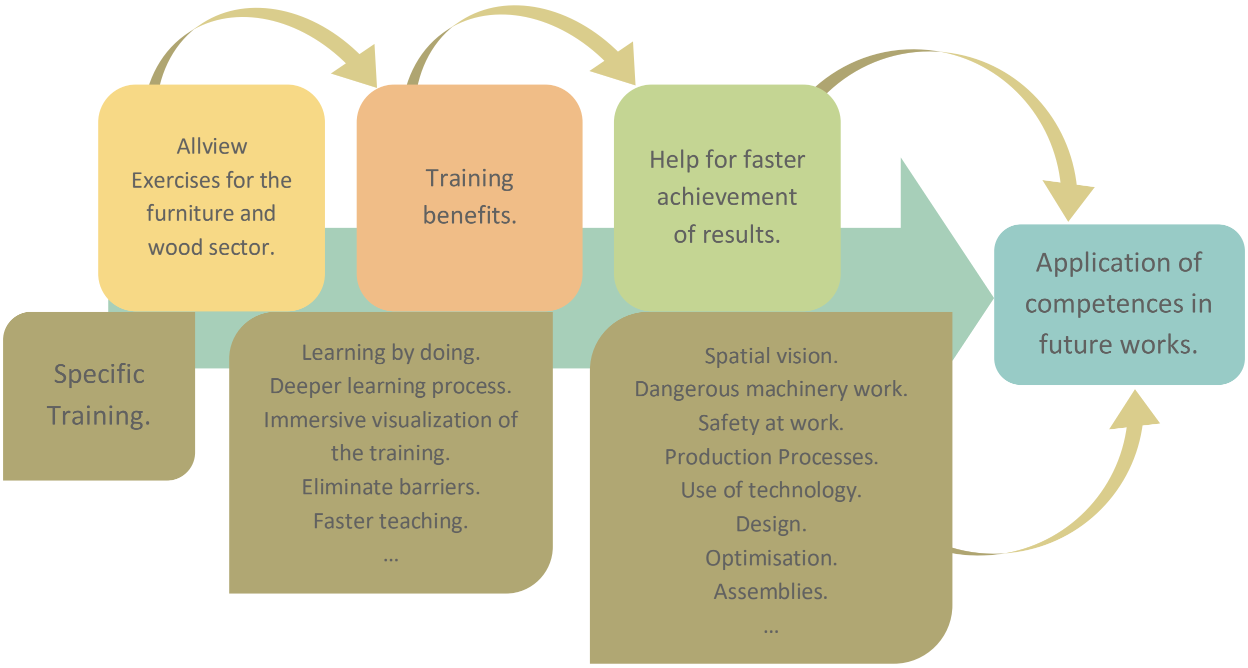


Graphic 1: Integration of Technologies in the Classroom.

For this work package, 10 specific exercises have been developed (described in section 6) for the furniture and wood sector to put immersive technologies into practice in vocational training.

Through these exercises the future student (and teacher) will be able to learn how to use dangerous machinery in a safe way, learn about the assembly process of a piece of furniture, gain specific knowledge about furniture design and production, and acquire knowledge about prototyping systems and design methodologies. In addition, students will become familiar with these technologies to be prepared for the demands of the jobs of the near future.

We employ gamification, project-based, and challenge-based methodologies to integrate these exercises into the classroom. The graph below illustrates the benefits and progress of integrating Allview exercises into vocational training in the wood and furniture sector.



Graphic 2: Integration of Allview exercises in the wood training.

In conclusion, the integration of extended reality technologies in vocational training for the furniture and wood sector offers significant advantages for both students and teachers. The use of immersive technologies can help develop technical, design, teamwork, problem-solving, and innovation skills in a practical and engaging way. Furthermore, the integration of XR technologies can improve teaching efficiency and drive innovation in sustainable furniture and materials. The Allview exercises developed for this sector offer a range of opportunities for students to learn and acquire specific knowledge about furniture design and production, while gaining familiarity with these technologies to prepare them for future jobs. By employing gamification, project-based, and challenge-based methodologies, students can enjoy a fun and interactive learning experience while achieving significant progress in their learning outcomes. Overall, the integration of extended reality technologies in vocational training for the furniture and wood sector represents a significant step forward in the digital transformation of education and promises to deliver new opportunities for both students and teachers while promoting the sustainability in the sector.

All the results of this work package, together with other training modules, will be available on the Allview e-Learning platform which will be accessible through the project website.

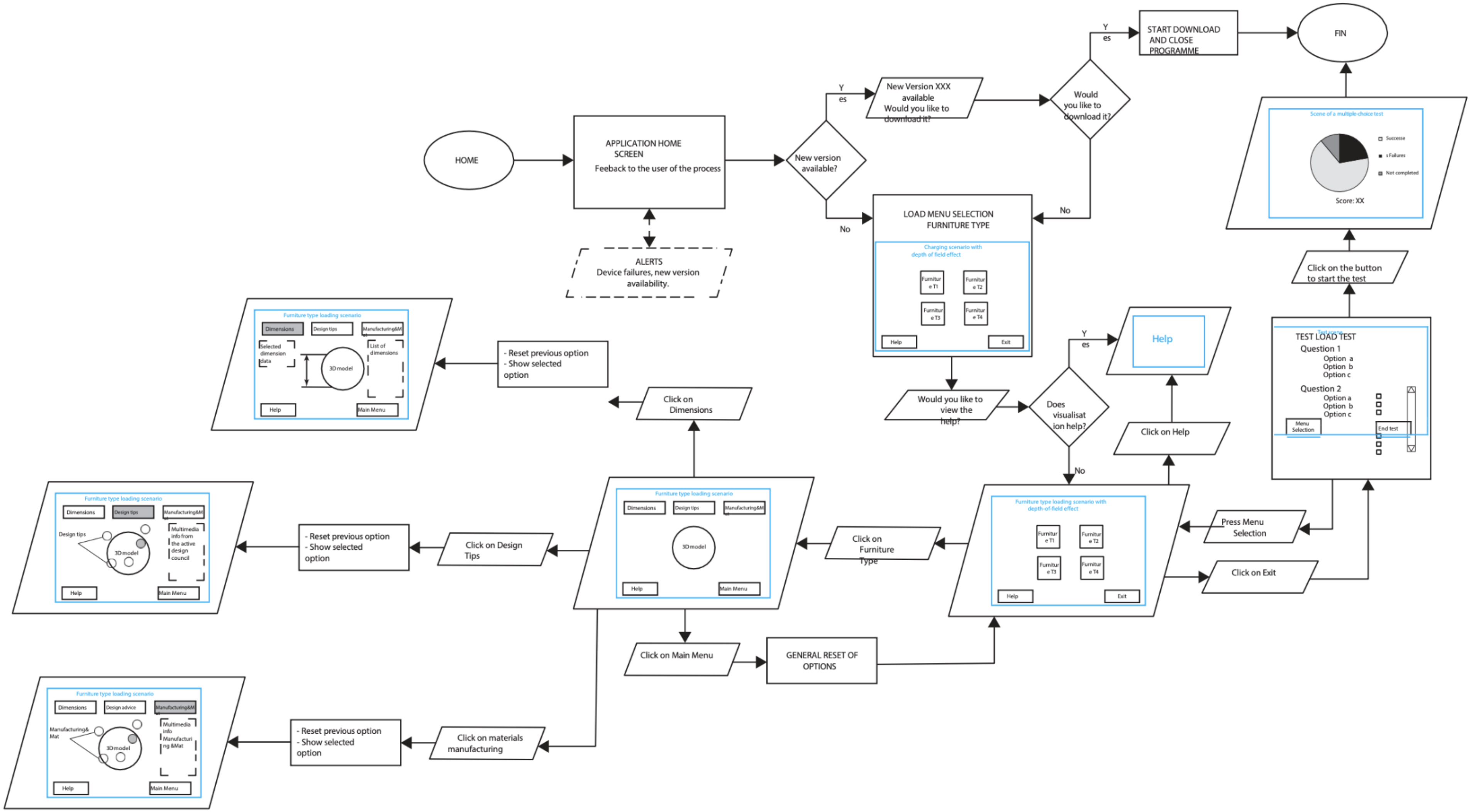
We hope that this report will help interested educational institutions to get started with these technologies and to integrate them into their curricula.

8

Annexes

8. Annexes

Annex 1: Low Fidelity Prototype – Allview App.



Annex 2: High Fidelity Prototype – Allview App-


Allview


Dimensiones recomendadas
Altura de asiento
Profundidad asiento
Anchura asiento
Inclinación asiento
Altura lumbar
Angulo asiento - respaldo
Altura respaldo
Altura brazo
Distancia entre brazos
Anchura brazo
Longitud brazo
Inclinación brazo
Angulo libre bajo asiento
Allview


Consejos en el diseño
Para ángulos de respaldo considerables, el reposacabezas mejora considerablemente la comodidad posturar de la raquis cervical. Es aconsejable que sea de altura regulable, dado que un reposacabezas mal situado es un motivo de gran incomodidad.

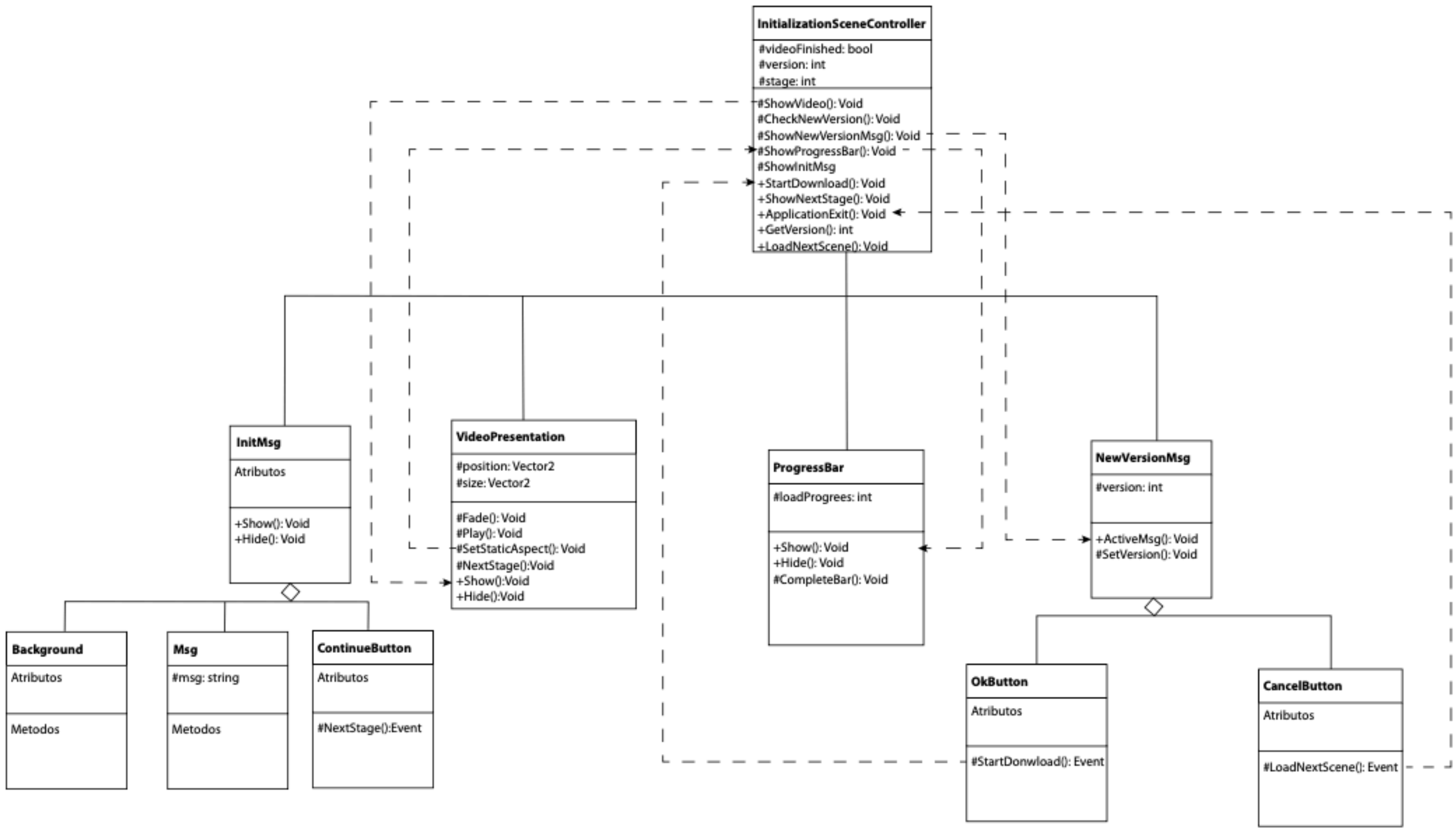

Tecnicas & Materiales
Lorem ipsum dolor sit amet, consectetur adipiscing elit.
Lorem ipsum dolor sit amet, consectetur adipiscing elit.

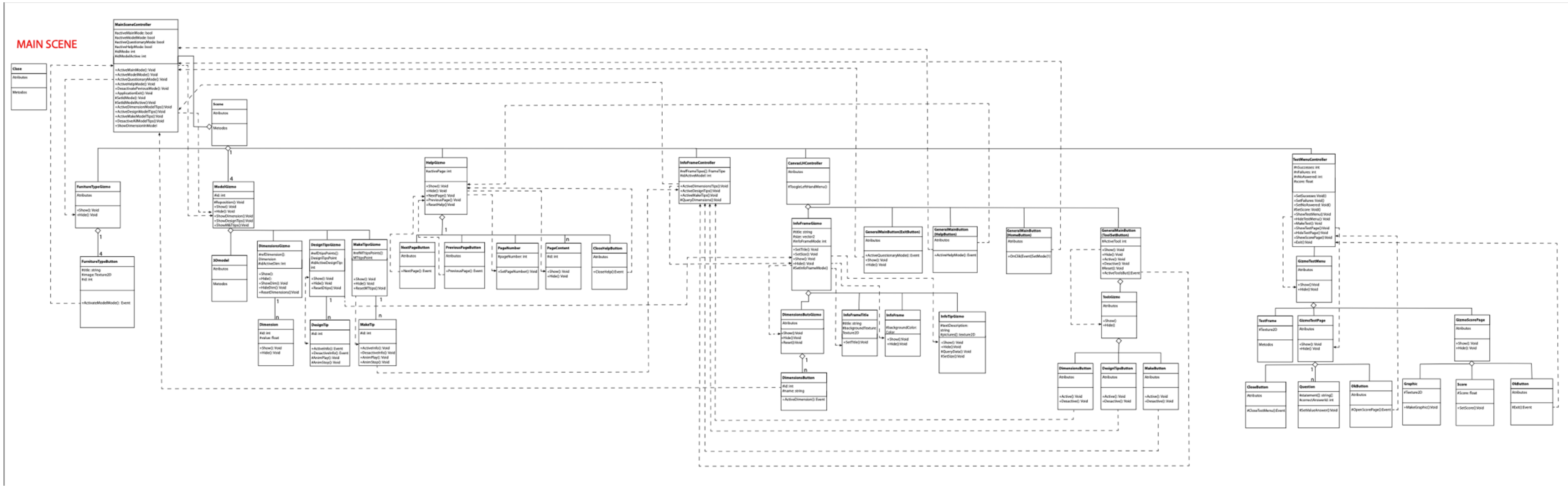

Allview


MesaComedor
Silla oficina
Allview
Sofa
Cama geriatria

Annex 3: Class Diagram – Allview App-

INITIALITZATION SCENE




MAIN SCENE

Annex 4: Low Fidelity Prototype – 360 Tours

FABLAB TOUR

1
CETEM, furniture and wood research institute

HOTSPOTS:
1-Entry point to Pano2
2_Intro: Using CETEM's introductory video button, we could use part of the videos from: M:`Videos 25th anniversary.

General Audio: Outdoor sound city - countryside.

A brief description of the use of the mouse in the experience would appear as an interactive introduction.

MENU
HotsPots ON / OFF Map ON / OFF Audio ON / OFF
Full Screen ON / OFF HELP ON / OFF

RECEPTION HALL

HOTSPOTS:
1-Entry point to Pano3
2-Entry point to Pano1
3-Areas: Information Point commenting on the different departments and areas that make up CETEM.
4-CartelAsociados: Comment on the company format that is CETEM and the associates that form it.

General Audio: Office hall not too stuffy.

MENU
HotsPots ON / OFF Map ON / OFF Audio ON / OFF
Full Screen ON / OFF HELP ON / OFF

5
Prototipes Workshop

HOTSPOTS:
1-Entry point to Pano4
(On or around the table, material relating to 3 or 4 projects would be displayed and would be interactive zones to be clicked on).
2-Project 1
2-Project 2
4-Project 3
5-Project 4

Audio General: music (technology - proactivity - dynamics).

MENU
HotsPots ON / OFF
Map ON / OFF
Audio ON / OFF
Full Screen ON / OFF HELP ON / OFF

Product Engineering Department

HOTSPOTS:
1-Entry point to Pano3
2-Entry point to Pano5 (In this case it could be the gate)

3-General information point on PC's area of work, commenting on general aspects of the projects and services department. It should be clear that there are two main lines of work, projects and services, and that to support these two areas we have two laboratories, the FAB LAB and the testing laboratory.
*A video has been made, the voice remains to be translated into English.

4-Scanner: Service and technology information
5-Supercomputer: Explanation of 3D-related services, product configurators, etc.

Audio General: music (technology - proactivity - dynamics).

MENU
HotsPots ON / OFF Map ON / OFF Audio ON / OFF
Full Screen ON / OFF HELP ON / OFF

CETEM DESIGN AWARDS EXHIBITION

HOTSPOTS:
1-Entry point to Pano2
2-Entry point to Pano4 (In this case it could be the gate)
3-Entry point to Pano6(Hidden until you have entered Pano4)
4-Information about the design competition 5-Arealnteractiva, video first prize
6-Arealnteractiva, video second prize 7-Arealnteractiva, video third prize

General Audio: Music (technology - proactivity - dynamics).

MENU
HotsPots ON / OFF
Map ON / OFF
Audio ON / OFF
Full Screen ON / OFF HELP ON / OFF

FABLAB Facility

HOTSPOTS:
1-Entry point to Pano3
2-Robot zone entry point
3-Entry point zone Finishing
4-Entry point Additive manufacturing laboratory
5-Entry point Pano10

Audio General: music (technology - proactivity - dynamics).

MENU
HotsPots ON / OFF Map ON / OFF Audio ON / OFF
Full Screen ON / OFF HELP ON / OFF

One prototype is to be left on a rotary table and one on a fixed table.

Robot Area

HOTSPOTS:
1-Entry point to Pano6
2-Large machining service info, video embedded: Resource Folder

Audio General: Robot movements, machining, etc.

MENU
HotsPots ON / OFF Map ON / OFF Audio ON / OFF
Full Screen ON / OFF HELP ON / OFF

8
Additive Manufacturing Area

HOTSPOTS:
1-Entry point to Pano6
2-Gigabot or Discovery
3-4-Envisióntec filament manufacturing system
5-Technology ZCorp
*Maximise information, if possible, include a video of the operation of the machine.

Audio General: 3D printer operation MENU
HotsPots ON / OFF
Map ON / OFF
Audio ON / OFF
Full Screen ON / OFF HELP ON / OFF

Preseries and Finishing Area

HOTSPOTS:
1-Entry point to Pano6
2-Workbench explaining the vacuum casting service and pre-series.
3-Paint booth
4-Sandblasting booth

General Audio: Painting or Sandblasting

MENU
HotsPots ON / OFF Map ON / OFF Audio ON / OFF
Full Screen ON / OFF HELP ON / OFF

TOUR FINISH PRODUCT LAB

1
CETEM, furniture and wood research institute

HOTSPOTS:
1-Entry point to Pano2
2_Intro: Using CETEM's introductory video button, we could use part of the videos from: M:\Videos 25th anniversary.

General Audio: Outdoor sound city - countryside.

A brief description of the use of the mouse in the experience would appear as an interactive introduction.

MENU
HotsPots ON / OFF
Map ON / OFF Audio
ON / OFF
Full Screen ON / OFF HELP
ON / OFF

RECEPTION HALL

HOTSPOTS:
1-Entry point to Pano3
2-Entry point to Pano1
3-Areas: Information Point commenting on the different departments and areas that make up CETEM.
4-CartelAsociados: Comment on the company format that is CETEM and the associates that make it up.

General Audio: Office hall not too stuffy.

MENU
HotsPots ON / OFF
Map ON / OFF Audio
ON / OFF
Full Screen ON / OFF HELP
ON / OFF

The entry point to Pano 3 will initially be located at the same entrance gate, next to the entry point.
to Pano1, if we see that the effect is strange, it is transferred to the descent of the staircase.

Innovation Factory

HOTSPOTS:
1-Entry point Pano4
2-Entry point Pano3
3-Information point on the Innovation Factory and the different extensions the centre has undergone.

General Audio: Outdoor audio field, birds, etc. MENU
HotsPots ON / OFF
Map ON / OFF Audio
ON / OFF
Full Screen ON / OFF HELP ON /
OFF

The shot is taken from inside the door of the car park, taking the corner of the building.

Finish Product Testing Lab Area

HOTSPOTS:
1-Entry point to Pano3
2-Entry point to Pano5
3-Information point in front of the laboratory overview, it should inform about the accreditation available for the laboratory (e.g. we could show the accreditation document), in addition, we should talk about the CE marking service and the range of tests and certifications offered by the laboratory.
M:IGHT BE DOCUMENTS CETEME AREAS, PROJECTS AND SERVICES SHEETS

Audio General: music (technology - proactivity - dynamics).

MENU
HotsPots ON / OFF
Map ON / OFF Audio
ON / OFF
Full Screen ON / OFF HELP ON /
OFF

5
Finish Product Testing Lab 1

HOTSPOTS:
1-Entry point Pano4
2-Point of entry Pano6 (Hall door)
3-Entry point Pano9
4-Information point fatigue tests (in big machine one sofa in small machine one armchair)
5-Information point, data collection and sample entry area.

Audio General: Audio laboratory test machines

MENU
HotsPots ON / OFF
Map ON / OFF Audio
ON / OFF
Full Screen ON / OFF HELP ON /
OFF

Mechanism testing area for large samples

HOTSPOTS:
1-Entry point to Pano3
2-Test service info for convertible and pull-down bed mechanisms

*We need to place some wall-hanging furniture, an office chair on a swivel table and a mattress on the fixed table.

Audio General: Robot movements.

MENU
HotsPots ON / OFF
Map ON / OFF Audio
ON / OFF
Full Screen ON / OFF HELP ON /
OFF

Finish Product Testing Lab 2

HOTSPOTS:
1-Entry point Pano5
2-Entry point Pano7
3-Entry point Pano8
4-General information point multi-test machine (with an i-symbol icon)
5-Information point seat-back fatigue (interactive area, we have to place a sofa)
6-Arm fatigue information point (interactive area, we have to place an armchair)
7-Information point durability tables (we must place a small table on the left side, interactive area).
8-Impacting information point

Audio General: Audio laboratory test machines

MENU
HotsPots ON / OFF
Map ON / OFF Audio
ON / OFF
Full Screen ON / OFF HELP ON /
OFF

8
Finish Product Testing Lab 4

HOTSPOTS:
1-Entry point Pano6
2-Information point pendulum impactor (place some chairs)
3-Machine information point compression lateral stability (use same sample as pendulum)
4-Stabilities information point (stabilities machine with a chair)
5-Information point measuring machine for office chairs

Audio General: Audio laboratory test machines

MENU
HotsPots ON / OFF
Map ON / OFF Audio
ON / OFF
Full Screen ON / OFF HELP ON /
OFF

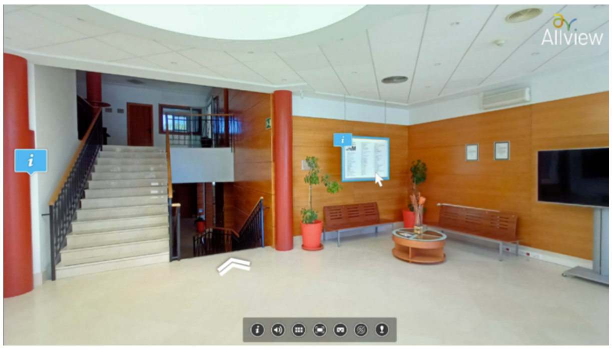
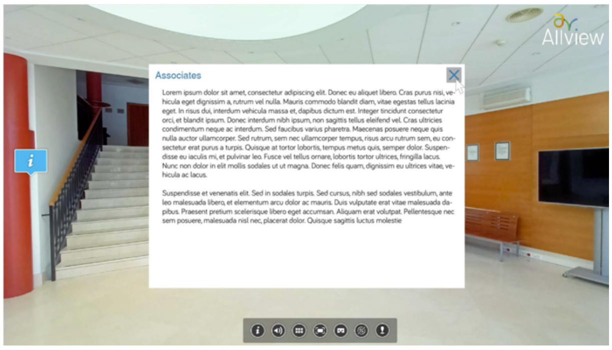
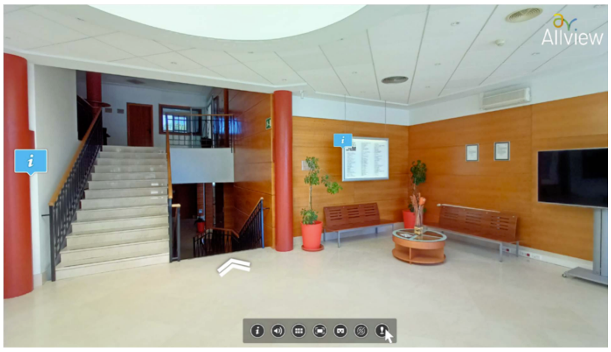
Finish Product Testing Lab 3

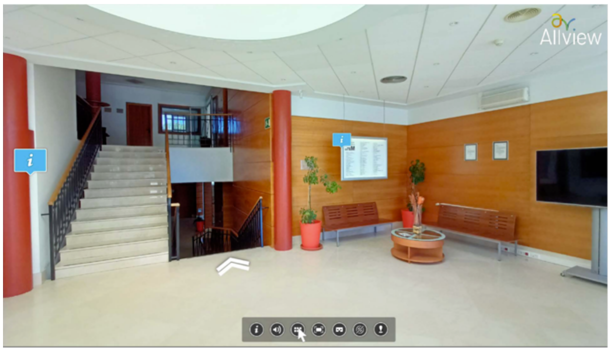
HOTSPOTS:
1-Entry point Pano6
2-Information point coffin rehearsal area
3-Information point in the testing area (if possible, we should place a piece of furniture with a sliding door or a drawer).
4-Stabilities information point (stabilities machine with a chair)
5-Information point medical control tests (ABB Robot pressing the geriatric bed control button panel)

Audio General: Audio laboratory test machines

MENU
HotsPots ON / OFF
Map ON / OFF Audio
ON / OFF
Full Screen ON / OFF HELP ON /
OFF

Annex 5: Low Fidelity Prototype – 360 Tours


Allview

Allview
Associates

Allview

Allview

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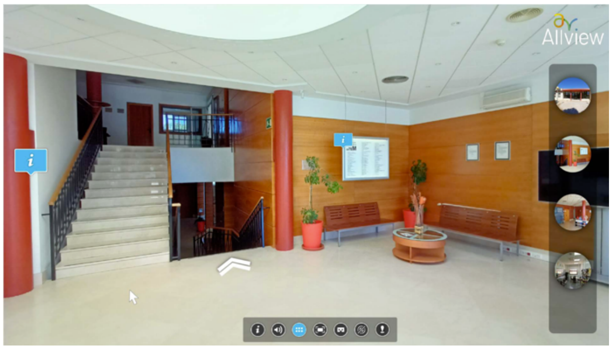
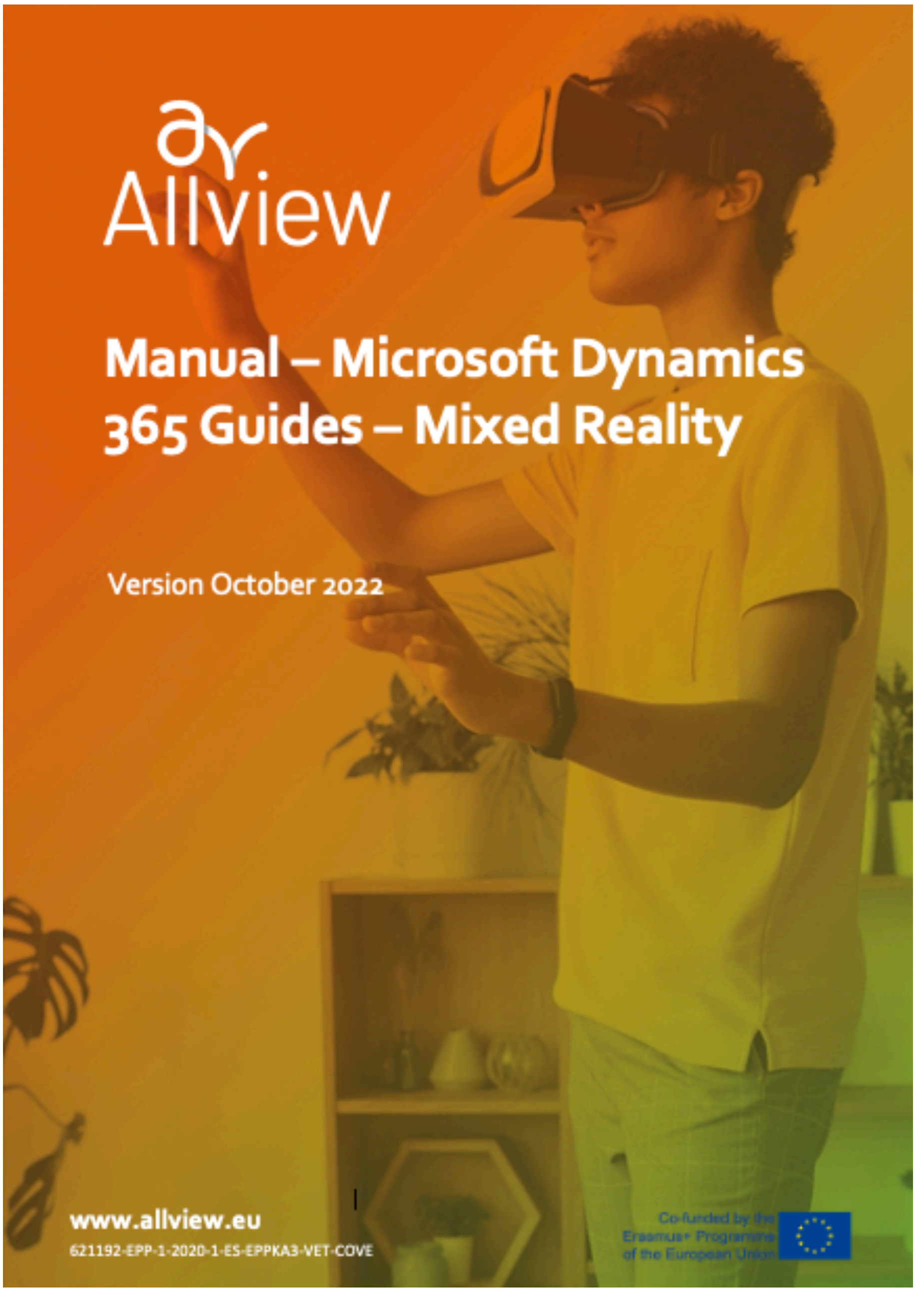

Allview

Annex 6: Manual Microsoft Dynamics 365 Guides – Mixed Reality.



Link to download the Manual:
https://drive.google.com/drive/folders/1qxhYWC2HtvVW9bd-UqUCO4M-UjxA-SXO?usp=share_link

Annex 7: Allview Extended Reality Exercise Videos

Below are links to the videos of these immersive experiences prepared for Allview.

https://youtu.be/LgWw5aB-zv4

https://youtu.be/BbAYgw_lZ8E

https://youtu.be/bNHBf4Xykzw

https://youtu.be/aHqDMcwDTOw

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